The significance of a Safety Data Sheet

MEDITERRANEAN ACTION PLAN (MAP)
REGIONAL MARINE POLLUTION EMERGENCY RESPONSE CENTRE FOR THE MEDITERRANEAN SEA (REMPEC)

INTERNATIONAL MARITIME ORGANIZATION

UNEP-PNUE

REGIONAL MARINE POLLUTION EMERGENCY

RESPONSE CENTRE FOR THE MEDITERRANEAN SEA (REMPEC)

MEDITERRANEAN ACTION PLAN

Guide for the significance of a Safety Data Sheet

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Note

This document is aimed at facilitating the implementation of the "Protocol concerning Co-operation in Combating Pollution of the Mediterranean Sea by Oil and Other Harmful Substances in Cases of Emergency" of the Barcelona Convention (Emergency Protocol, 1976) and the "Protocol concerning Co-operation in Preventing Pollution from Ships and, in Cases of Emergency, Combating Pollution of the Mediterranean Sea" (Prevention and Emergency Protocol, 2002) by the Contracting Parties of the Barcelona Convention.

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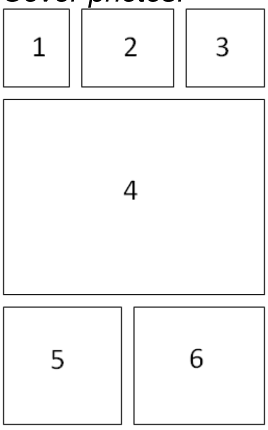

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THE SIGNIFICANCE OF SAFETY DATE SHEET

1. INTRODUCTION

In recent years the transportation of hazardous substances by ships has increased considerably and with it so have the risks of accidents and the risks of spillage.

An uncontrolled release of chemicals may be hazardous to human life and/or to the environment. In the latter case, this can mean damage to marine living resources or the ruin of amenities, both of which have possible adverse financial repercussions.

It is essential to obtain as much information as possible concerning the identity of the chemical or chemicals to be able to respond effectively to a chemical spill. The carriage of a single substance by a ship would obviously facilitate the identification process only requiring confirmation from shipping papers or the shipping company. On the other hand, if more than one substance is being shipped, additional meticulous investigation is required in particular when the cargo is mixed inadvertently due to the incident.

An important feature in planning the response to a marine chemical emergency is to be informed of the potential hazards (e.g. fire, explosion and toxic effects) that the chemical might pose.

To assess the potential hazard and to subsequently plan the response, information pertaining to the circumstances of the accident as well as to the information on the actual material spilled is required. In order to be aware of the hazards presented by the chemical spilled as well as to be cognizant of the safety measures needed to protect both public and response personnel, the following information on a chemical cargo is required:

- physical and chemical data;
- safety data and instructions (e.g. safe handling instructions, toxicity, ecotoxicity);
- personal protective clothing and equipment;
- first-aid measures;
- information to doctors; and
- fire-prevention and fire-fighting instructions;
- counter measures in the event of a spill.

Quite often this type of information is presented in a synthesized manner in the form of a **Safety Data Sheet**, **Material Safety Data Sheet (MSDS)**, **Product Data Sheet** or **Response Information Data Sheet**. Data sheets on specific substances are prepared by various international or national organizations as well as by chemical companies which produce or supply the goods for shipment. Regulations exist within the European Union which specify the information that should be included in a Safety Data Sheet prepared by a chemical company. According to these regulations, the information contained in a Safety Data Sheet should be organized in sixteen sections;

1. Identification of the substance and manufacturer;
2. Composition / information on ingredients;
3. Hazard identification;
4. First aid measures;
5. Fire-fighting measures;
6. Accidental release measures;

7. Handling and storage;
8. Exposure controls / personal protection;
9. Physical and chemical properties;
10. Stability and reactivity;
11. Toxicological information;
12. Ecological information;
13. Disposal considerations;
14. Transport information;
15. Regulatory information; and
16. Other information.

In the U.S.A., regulations specify the information to be included in a Safety Data Sheet but they do not specify the precise format, although all, as a minimum, must include the following information:

- Heading;
- Material identification;
- Ingredients and hazards;
- Physical data;
- Fire and explosion data;
- Reactivity data;
- Health hazard information;
- Spill, leak, and disposal procedures;
- Special protection information; and
- Special precautions and comments.

Thus, although data sheets on a particular chemical prepared by different sources might not look the same and the data might not be presented in the same way, these all contain certain basic information which is common to all data sheets and essential for making an initial assessment of the hazard of a chemical(s). This can be divided as follows:

- Identification and use of product;
- Packaging and transportation;
- Physicochemical properties;
- Fire and explosive hazards;
- Human health information;
- First-aid measures;
- Reactivity information;
- Eco-toxicological information; and,
- Preventive measures.

2. IDENTIFICATION AND USE OF PRODUCT

Product or chemical identification and use is normally the first section of a data sheet and includes information such as:

- the name of the product;
- alternate names (synonyms) including trade names; identification numbers; for example the C.A.S. or U.N. Nos. ;
    - C.A.S. No.; this is the Chemical Abstracts Registry Number which is a number sequence adopted by the Chemical Abstracts Service Division of the

American Chemical Society to uniquely identify specific chemicals. In the example below 108-88-3 identifies toulene;

- U.N. No.; this is the number sequence given by the United Nations Committee of Experts on the Transport of Dangerous Goods to uniquely identify specific chemicals. In the example below, 1294 identifies toluene.

<u>Figure 1.</u> Name: Toluene

C.A.S. No. 108-88-3 (Number given by the Chemical Abstracts Registry);
U.N. No. 1294 (Number given by the United Nations Committee of Experts on the Transport of Dangerous Goods);
Other names: Toluol; Methyl benzene; Phenylmethane; Methylbenzol.

- the main uses of the product;
- the chemical formula which can only be given for a pure chemical product. The chemical formula could be either empirical, semi-structural or structural with the symbols in a formula expressing the elements of a specific chemical; e.g. CH3CN is the semi-structural formula for acetonitrile;
- the ingredient disclosure data which applies to chemical products with more than one ingredient. The concentration of the various components is usually expressed as a percentage as one of the following ratios;

  - weight of component/weight of mixture (w/w);
  - weight of component/volume of mixture (w/v); or
  - volume of component/volume of mixture (v/v).

<u>Figure 2:</u> ABC antifreeze containing water (80%), ethylene glycol (19.9 %) and yellow dye (0.1%)

When an emergency call is received by an emergency response Centre, the officer-on-duty will attempt to obtain information on the emergency and recommend initial response actions to protect the public and to stabilize the situation. The officer-on-duty will also seek advice from a specialist who can provide him with technical information regarding the physical, chemical, toxicological and other properties of the products involved: recommend remedial actions for fires, spills or leaks; provide advice on protective clothing and first-aid; the officer-on-duty may even contact the shipper, manufacturer or any other organization he deems necessary.

When communicating between emergency response Centre and the site or between the emergency response Centre and third parties, the correct spelling of the product is paramount to proper identification, for example;

- **Ammonium sulphide** is poisonous, flammable and corrosive;
- **Ammonium sulphite** is a mild corrosive.

The complete name of the product is also essential in product identification, for example:

- Acetone: flammable;
- Acetone cyanohydrin; flammable and poisonous.

The phonetic alphabet may be helpful to ensure accurate spelling and transmittal of information (see **Annex II**).

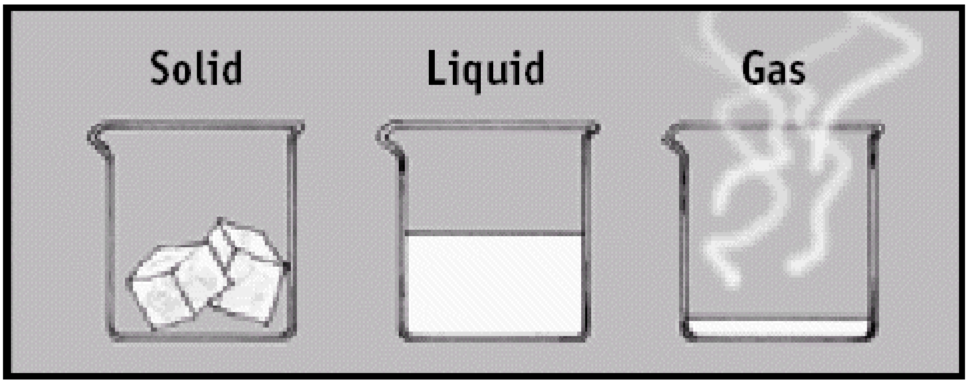
3. PACKAGING AD TRANSPORTATION

In a Safety Data Sheet, the section describing the **packaging and transportation** of a chemical will provide information as to what transportation class, (generally as per **United Nations Classification)**, a substance belongs as well as details on the labelling of packages (drums, intermediate bulk containers and cargo transport units) and maximum quantities allowable for the transportation by road, sea and air.

The U.N. Classification (see **Annex III** for the description of the U.N. Classification, definition of classes and associated labels) is an internationally recognized standard whereby hazardous substances are divided into nine classes according to their hazardous profile. Under this classification, each class is characterized by a numerical value with certain substances accorded a second number to denote a subsidiary hazard. It must be noted that the numerical order of the classes is not a reflection of the physical hazards of a chemical product and its main objective is safety during transport and handling. However, this classification can be used for identification and situation analysis in responding to hazardous material spillages.

4. PHYSIOCHEMICAL PROPERTIES

The physicochemical properties describe the physical and chemical characteristics of a chemical in relation to either standard temperature (usually 20°C.) and standard pressure (e.g. 1 atm., 1.013 bars, 14.696 psia, 101.33 kPa) or to other specified conditions. The data are used by specialists to develop specific procedures for exposure control, spill clean-up, safe handling and storage. The following are some common available properties which are useful in assessing the hazards of a chemical.



a) The **Physical State** which indicates whether a product is a liquid, solid or gas under normal condition

Figure 3. ***The physical state indicates whether the product is in the gaseous, liquid or solid state at standard temperature or pressure.***

This property is important for determining the extent of dispersion of the spilled substance and on what course of action should be taken to reduce the effects of chemical spillages.

A solid has shape and volume, a liquid has volume but no shape whilst a gas has neither shape nor volume. A gas will have the greatest dispersion of all three phases.

It should be noted that the physical state of a product in its normal state might be different from that of the product when transported. The first step in determining how a substance will behave upon release into the environment also requires knowledge of the physical state of the material within its storage or transportation container. This in turn requires knowledge of the relationship between the temperature of the material, its boiling point and melting point. The possibilities are:

- the temperature of the material in its container is less than its melting point, in which case the material is a solid in its container. A good example would be dry table salt in a large drum;

- the temperature of the material in its container is greater than the melting point of the material but less than its normal boiling point, in which case the material is a liquid and the container contents are approximately at normal atmospheric pressure. An example is water in a tank at temperatures above freezing. Such liquids, however, could also consist of substances that are normally solids but which have been melted and maintained at relatively high temperatures to keep them liquid. They could also be substances which are normally gases in the natural environment but which have been liquefied via refrigeration;

- the temperature of the material in its container is greater than the boiling point of the material, in which case the material is a compressed gas (gas under high pressure in a cylinder or other container) or a liquefied compressed gas (a substance that is normally a gas at normal ambient conditions but which has been turned into a liquid by subjecting it to and maintaining it at high pressures, thus raising its actual boiling point).

The Table below summarizes the various possibilities in greater detail. The Table requires a bit of study for complete understanding, but the effort is extremely worthwhile.

b) The **Specific Gravity** (relative density) and **Density** that are data related to the weight of a specific volume of the chemical. Density is the weight of a product per unit of volume. The specific gravity expresses the number of times the chemical is heavier than water and hence determines its floatability. Under normal ambient conditions, should the value of the specific gravity be less than 1.03 for a given chemical, the chemical will float on seawater. On the other hand, should this value be greater than 1.03 the product will sink to the bottom. This information is useful in determining the initial behaviour of a chemical in the event of leakage or accident. For example, a solvent (common name given to products in the chemical industry which are used for dissolving other substances) such as toluene has a specific gravity of 0.866. Since this value is less than 1, it will float on water. It should be borne in mind, however, that other factors, such as miscibility with water, could also affect the extent to which materials float in water. Furthermore, the density of substances not transported in their natural state often differs to that of their natural state. Examples of these products carried at a different density are compressed, liquefied gases and molten solids.

c) The **Freezing Point** which is the temperature at which a substance changes from liquid to the solid state. This datum is usually quoted at standard atmospheric pressure. For a pure substance, the freezing point is equivalent to the **melting point**.

d) The standard **Boiling Point** which is the temperature at which a liquid becomes a gas at standard atmospheric pressure. The boiling point of a liquid depends on pressure. For example, when the atmospheric pressure is 93.31 kPa, water boils at 97.7°C., at 101.33 kPa, it boils at 100°C. The standard boiling point is the one usually listed in Safety Data Sheets.

TABLE

TYPICAL STATES OF MATERIALS IN STORAGE OR TRANSPORTATION CONTAINERS

Normal Melting or Boiling Points	Container Conditions	State of Material
Melting point less than ambient T	T less than melting point and less than ambient T	Cold solid
Melting point greater than ambient T	T near ambient T	Solid near ambient T
Boiling point greater than ambient T	T greater than melting point, greater than ambient T, but less than boiling point	Warm or hot liquid (molten solid)
Melting point less than ambient T	T greater than melting point but less than ambient and boiling point	Cold liquid
Boiling point greater than ambient T	T near ambient T T greater than ambient T but less than boiling point T greater than boiling point and greater than ambient T	Liquid at ambient T Hot liquid/ Hot or warm compressed gas or vapour over hot liquid
Boiling point less than ambient T	T near ambient T T greater than boiling point and greater than ambient T	Compressed gas or compressed liquefied gas under pressure at ambient T Hot or warm compressed gas or compressed liquefied gas under pressure at T greater than ambient

(Source: Handbook of Chemical Hazard Analysis Procedures)

[Notes: T = temperature within container; ambient T = temperature outdoors]

Other useful commonly available physicochemical are:

a) The **Vapour Density** which indicates the number of times that the vapours of a substance are heavier or lighter than air. For liquids, this measurement is taken at the boiling point. If the vapour density is greater than 1, the vapours will have tendency to accumulate near the ground or to accumulate in depressions before eventually mixing with the air. As a general rule of thumb, if the relative vapour density of a substance under prevailing discharge conditions exceeds 1.5, then vapours or gases may indeed behave as heavier-than-air (**negatively buoyant**) mixtures for some distance from the source of discharge. Conversely, a vapour density of less than 1 implies that a vapour-air mixture may be lighter than air (**positively buoyant**).

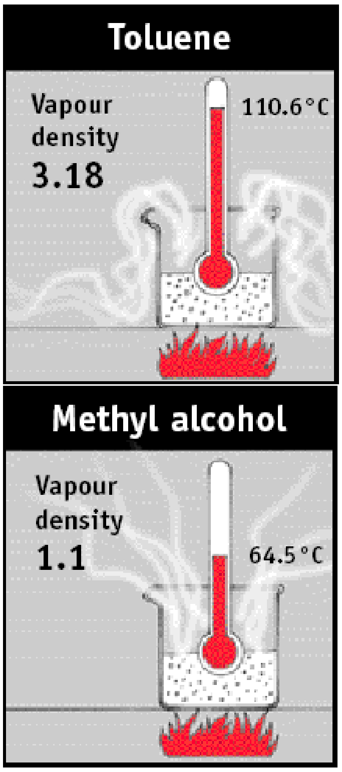


Figure 4. **Toluene has a vapour density of 3.18. Therefore, at its boiling point, its vapours will tend to remain at the ground. Methyl alcohol has a vapour density of 1.1. Therefore at its boiling point, its vapours will mix easily with air, since its vapour density is close to 1.**

Important to note, that a negatively buoyant vapour-air mixture will very quickly mix with the surrounding air as it drifts away from its point source and will rapidly approach the density of air. It will eventually behave as if there were little or no difference in its density as compared to that of air (**neutrally buoyant**).

b) The **Vapour Pressure** which indicates a substance's ability to form vapour. When a substance evaporates, its vapour exerts a pressure in the surrounding milieu. This is the vapour pressure. It is expressed in units of pressure at a particular temperature (usually at 20°C) and standard atmospheric pressure. The higher a substances vapour pressure, the more it tends to evaporate, whilst a vapour pressure above normal atmospheric pressure at ambient temperature (usually taken at 20°C) indicates a substance in the gaseous state.

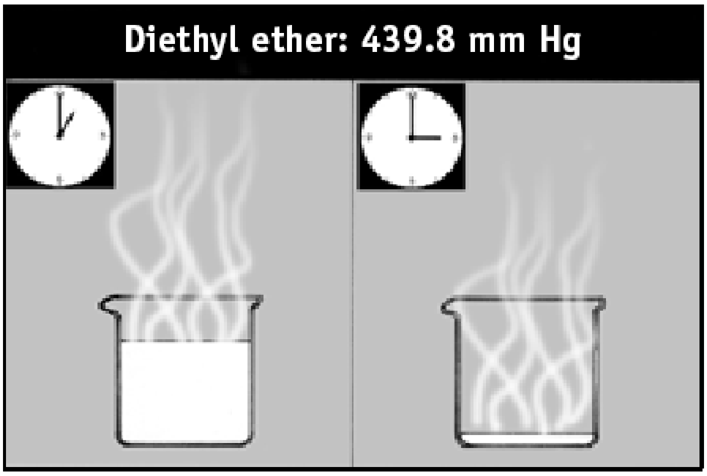


Figure 5. ***: Water has a vapour pressure of 17.5 mm of Hg, while ether's is 439.8 mm of Hg. Ether therefore evaporates faster than water.***

c) The **Molecular Weight** which is defined as the sum of the atomic weights of a molecule of the pure substance where the relative mass of each atom is based on a scale in which carbon-12 is assigned a mass value of 12. The vapour density of any substance can be computed by a shortcut method involving division of the molecular weight of a substance by the molecular weight of air, the latter being approximately 28.8 (as the weighted average for the mixtures of gases that comprise air: oxygen 20.93 vol. %; nitrogen 78.10 vol. %; carbon dioxide 0.03 vol. %; noble gases etc. 0.94 vol. %). The molecular weight is also useful in converting pressure, volume and temperature relations for gases or vapours.

d) The **Evaporation Rate** which expresses the speed at which a particular substance turns into vapour. Speed of evaporation varies according to the nature of the product and temperature. As a rule, low molecular weight organic liquids evaporate more quickly and at a lower temperature than water. Longer chained organic compounds evaporate more slowly than shorter chained ones.

e) The **Water Solubility** which is the maximum quantity of the chemical that can be dissolved in water. This datum is generally expressed as a weight of substance per volume of pure water at a specific temperature chemical manufacturer's use certain terms to express solubility. No standard scheme exists to quantify these solubility terms. The following Table developed by Environment Canada can be used as a guidance to interpret solubility terms.

DESCRIPTION	SOLUBILITY (g/100mL WATER)
Soluble in all proportions	>>100
Very soluble	>50
Soluble	10 to 50
Moderately soluble	1 to 10
Slightly soluble	0.1 to 1
Insoluble	<0.1

f) The **Coefficient of Water/Oil distribution** which is a ratio of a substance's distribution between water and oil when the two are in contact. A value of less than 1 indicates better solubility of the substance in oils and greases. This is also an indication of the lipid solubility of a substance and that a chemical is likely to be absorbed by the skin. A chemical having a value greater than 1 indicates better solubility in water and hence such a chemical could be absorbed by the mucosa. This information can be useful in assessing whether a substance will bioaccumulate, and first aid requirements as well as help in the selection of proper protective equipment.

g) The **pH** which specifies whether a particular chemical is an acid or a base (alkali). It is measured on a logarithmic scale of 1 to 14. Each change of 1 unit is equivalent to a ten-fold change in pH strength. A pH of 7 indicates neutrality; a pH between 0 and 3 indicates a strong acid; and a pH between 11 and 14 indicates a strong base. Both acids and bases are corrosive to the skin, and the pH strength of a chemical gives an indication of the need for protective clothing.

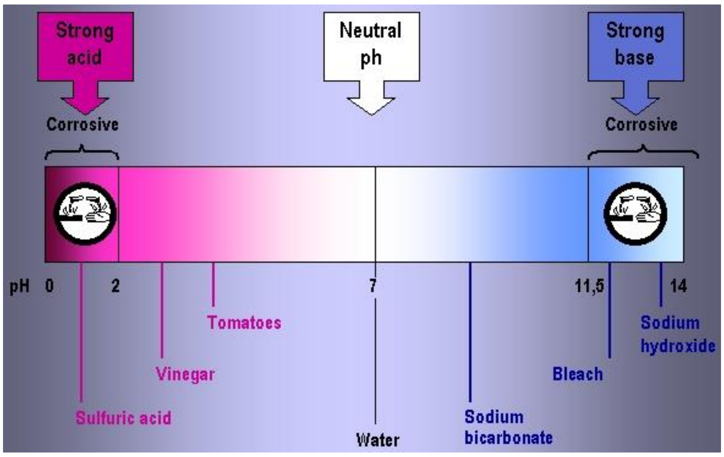


***Figure 6**: pH is expressed by a numerical value indicating whether a solution is acidic or basic. The lower the value, the stronger the acid. The higher the value, the stronger the base.*

h) The **Granulometry** which indicates the size of particles in a powder and is usually expressed in microns (0.000001 of a metre). Particles of less than 10 microns are capable of deep penetration and deposition in the respiratory system. The knowledge of particle sizes is valuable in determining ventilation requirements and protective respiratory equipment.

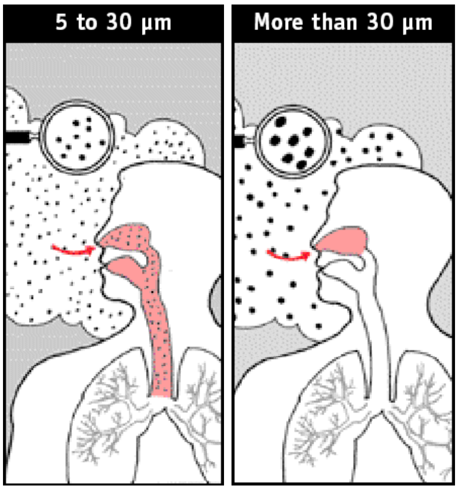


***Figure 7:** This datum expressed in microns indicates the size of particles in a powder.*

Other physicochemical properties commonly reported in a Safety Data Sheet are the colour, odour and appearance. Although these might not be useful on their own, they are able to provide additional clues when considered with other information found in a sheet.

a) The **Colour** and **Appearance** characteristics which further specify the physical state of a chemical. When the colour is specified, any deviations can indicate the presence of contaminants. If the product is a solid, it may be crystalline, granular, powdery, etc. If the product is liquid, it may be viscous, heavy etc. This type of information may assist in determining the feasibility of using pumping as a recovery method.

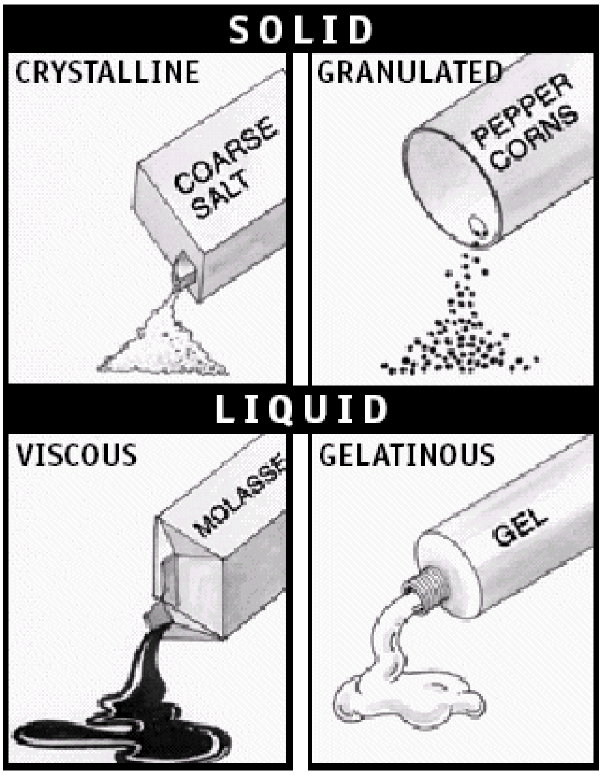


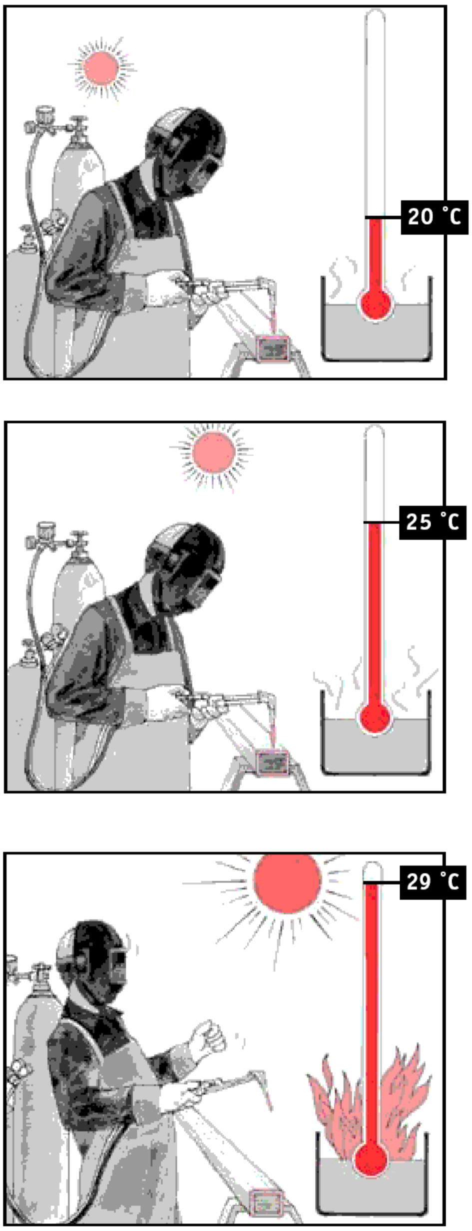
***Figure 8:* The appearance further specifies the physical state of the product.**

b) The **Odour** which is also a physical characteristic of the product and is expressed in descriptive terms such as fruity, aromatic, ethereal etc. Related to the odour is the **Odour Threshold** or **Olfactory Identification Limit** which is lowest concentration in the air in which the substance can be detected by the human sense of smell. It is usually expressed in parts per million (ppm). This information can assist the evaluation of the warning properties of the chemical and selection of respiratory protection, however, threshold values should not be relied upon to prevent over-exposure since human sensitivity to odours varies widely, whilst odours could be masked by others and some compounds can damage and eventually destroy the sense of smell. There is also some scientific evidence, albeit inconclusive that substances with an odour threshold of greater than 1mg/ml may have the potential to taint seafood.

5. FIRE AND EXPLOSIVE PROPERTIES

The section on fire and explosive hazards in the Safety Data Sheet explains a substance's flammability, fire and explosive prevention procedures and emergency response. Although descriptive in nature some technical terms also occur. Common technical terms which can be encountered are:

a) The **Flash Point** which is the lowest temperature at which vapours given off by a volatile substances can be ignited in air when exposed to a flame or spark (the lower the flash point, the greater the risk of fire). Thus for example, a liquid that has a flash point of 35°C is highly flammable on a hot summer day or in a hot working environment when its vapours come into contact with an open flame or spark. Two major test methods exist for the determination of the flash point of a chemical: the closed-cup method, (c.c.); measurements are made inside a container, or: the open-cup method, (o.c.); measurements are made near the surface of the liquid. As a rule the value obtained by the open-cup method is a few degrees higher than obtained by the closed up one. Due to factors such as the purity of the sample tested, it is not surprising to find a number of different closed or open cup flash points for any given substance, all of which may differ to some extent. It is well to consider flash point values reported in the literature as approximate rather than exact values



***<u>Figure 9:</u>* Normal butanol has closed cup flash point of 29°C. it is therefore highly flammable on a hot summer say if its vapours come into contact with an open flame or spark.**

b) The **Autoignition Temperature** which indicates the temperature at which spontaneous combustion may occur in the absence of any flame or spark. This datum should not be confused with the flash point and the ignition temperature. The closer the auto-ignition temperature is to ambient temperature, the greater the risk of fire. In essence the auto-ignition temperature signifies the temperature at which material must be heated in order to cause them to explode or ignite. It is therefore important to realise that ignition can be caused by hot surfaces such as cookers or steam pipes in addition to an exposed flame, sparks or static electricity. Consideration to the presence of flammable material must therefore be given before any hot work (work requiring the use of welding, burning or soldering equipment, blow torches, power-driven tools, portable electrical equipment etc.) is approved.

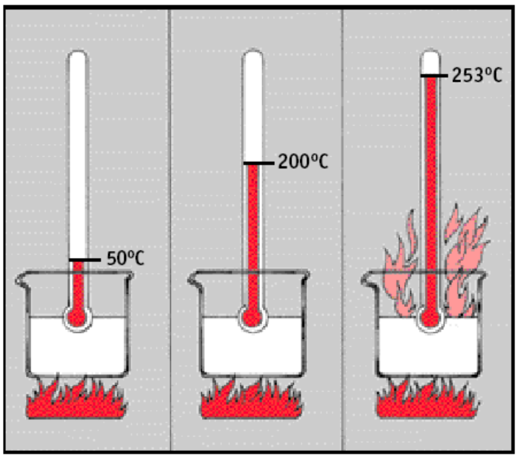


Figure 10: ***Turpentine has an auto-ignition temperature of 253ºC. It will therefore not ignite by itself at ambient temperature.***

c) The **Upper and Lower Flammable (UFL, LFL) or Explosive Limits (UEL, LEL)** which are the minimum and maximum concentrations of vapours of a substance in the air forming a mixture that are flammable or explosive in the presence of ignition sources. The words flammable and explosive are used interchangeably such that UFL/LFL values typically equal UEL/LEL values in literature. The reasoning behind this is that the concentration of a fuel that will burn in air can also be expected to explode under the certain conditions. Expressed as a percentage of the volume of vapour or gas in the air, concentrations below these limits are too lean to ignite whilst concentrations above are too rich and the air-chemical mixture is such that it does not contain enough oxygen for an explosion to occur. It is therefore necessary to keep the concentration of a chemical in the air below its lower explosive to avoid the possibility of an explosion.

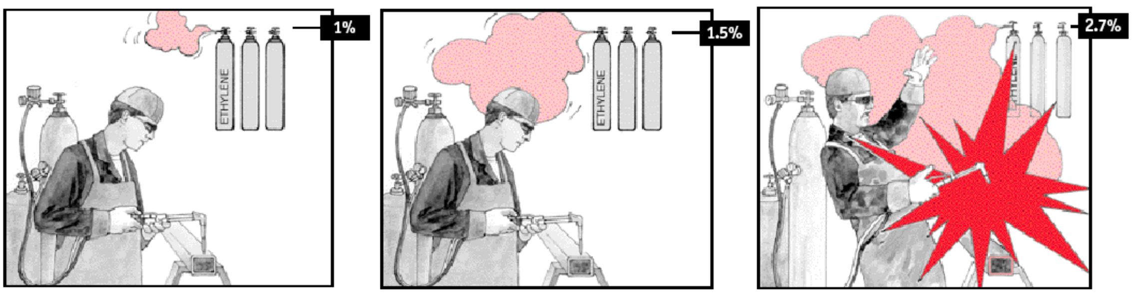


Figure 11: **Ethylene has a lower explosive limit of 2.7% and an upper limit of 36%. Therefore, in the presence of an ignition source, if the concentration of the gas is less than 2.7% or greater than 36%, there is no risk of explosion. But if the concentration of the substance is between these two limits, the mixture could explode. The concentration of the product in the air must be kept under its lower explosive limit, for example by using appropriate ventilation**

LFL or LEL values are related to flash points in that the flash point is theoretically the temperature at atmospheric pressure to which a substance must be raised to produce a vapour or gas concentration over its surface equivalent to its LFL or LEL concentrations.

The relationship is not always observed in practice, however, because flash point measurement equipment and procedures, as discussed above, do not always produce precise values.

Flammable and explosive limits reported in Safety Data Sheets are usually measurements made at normal atmospheric temperatures and pressures unless indicated otherwise. There can be considerable variation in these limits at pressures or temperatures above or below normal. The general effect of an increase in temperature or pressure is to reduce the lower limit and increase the upper limit. Decreases in temperature or pressure have opposite effect.

It is also important to appreciate that certain solids, when dispersed in air as fine powders, may also be capable of burning or exploding upon encountering a suitable source of ignition. Some examples include coal dust produced in unloading/offloading ship operations and grain dust produced in silos during storage or transfer operations. Flammable or explosive limits for solid materials are usually expressed in units of weight of solid present in a specified volume of air although these are not commonly found in safety data sheets.

Other data which can provide information on the fire and explosive characteristics of a substance are:

a) the **Fire Point** which is the temperature at which vapours will ignite and continue to burn due to self-sustaining combustion. The value is about 7 per cent above the open-cup flashpoint value. These temperatures are available for only a relatively few materials. The data are generally used for quality control testing of lubricating oils.

b) the **Electric Conductivity** which if lower than $10^4 pSm^{-1}$ can generate electrostatic changes as a result of flow, friction or other action through pumping, stirring, filtration etc. Conductors such as pumps, drums piping etc. become electrically charged and may discharge to “earth” via sparks. When such substances are handled all equipment must be earthed, since sparks have been caused by inadequate earthing of the conducting parts (such as pumps, drums, piping etc.) or by discharge of a charged dust or mist cloud. Besides earthing, there are other means of preventing undesirable discharges or inhibiting the generation of changes. In some cases of mist and dust explosions, it has been assumed that static discharge has been the ignition source.

Other information that may be encountered which is related to the section on fire and explosion hazards is that on hazardous combustion products. It must be emphasized that although the information in a data sheet might indicate that a chemical is “non-flammable”, in the event of a fire this chemical may still give off poisonous gases.

6. REACTIVITY DATA

The **Reactivity data** deals with topics such as the **stability, incompatibility, reactivity and polymerization** properties of the chemical concerned. This data will provide information on whether or not the product is stable and, if necessary, the conditions that create instability. It will also provide information on whether a chemical can be placed in contact with others (incompatibility) an whether a chemical is likely to react violently or dangerously under normal conditions of use (reactivity). Information on **hazardous decomposition products** is also important as substances released when a chemical decomposes or ages can be dangerous at times.

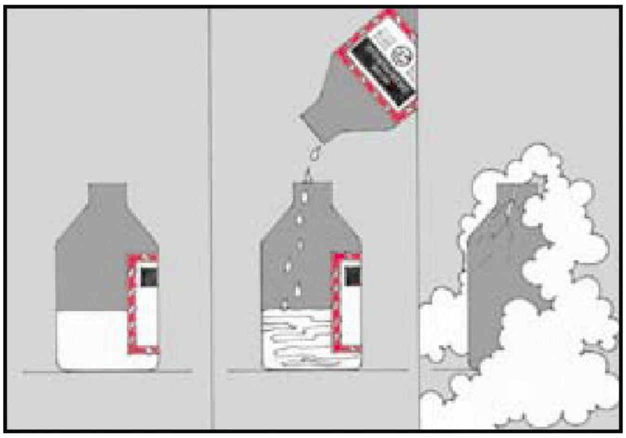


Figure 12: ***Exposure to light or contact with strong bases or acid can cause acrolein to polymerize, expand, burst its container, release energy and eventually spill.***

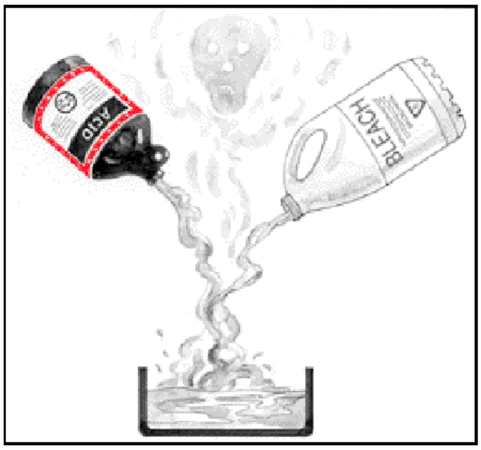


Figure 13: ***Sodium hypo-chlorite (household bleach) is incompatible with strong acids. On contact with them, it releases highly toxic chlorine vapours.***

7. TOXICOLOGICAL AND HEALTH DATA

Toxicological/health hazard data is of great importance for response personnel and for people who have to handle hazardous materials. The toxicity data are mainly intended for medical professionals, occupational and safety professionals and human toxicologists. Information provided could include that on:

- Routes of entry; a hazardous material may enter the body through inhalation, ingestion, cutaneous absorption while the eyes are especially vulnerable to exposure;
- Acute and chronic health effects; adverse health effects can result from short-term exposure or from long-term exposure;
- Symptoms of exposure; a description of how a victim of exposure might look or act like;
- Medical conditions aggravated by exposure; usually expressed in description terms which at times are not easily understood by non-medical personnel. A medical dictionary or a health care professional should be consulted to explain the medical and pathological terminology. Common terminology used are:

  - teratogen/teratogenic effects;
  - mutagen/mutagenic effects;
  - carcinogen/carcinogenic effects.

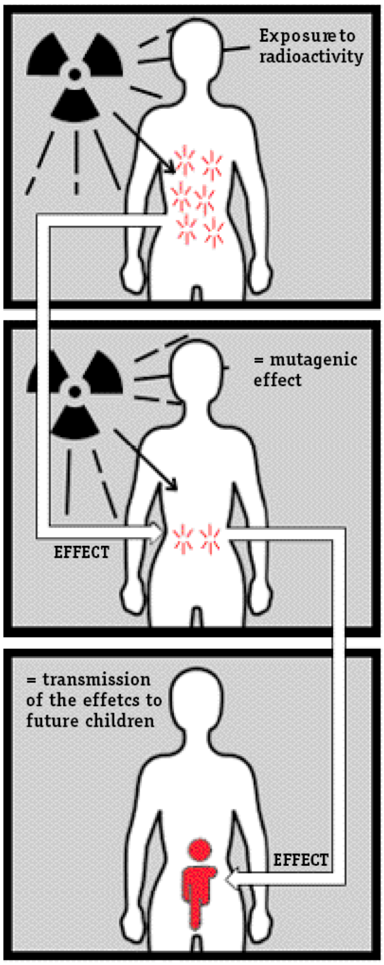


Figure 15: A mutagen is a chemical product that causes changes to the heredity-carrying material (genes) e.g. 5-fluoro uracil

Figure 16: A carcinogen is a chemical products causes cancer e.g. benzo (a) pyrene

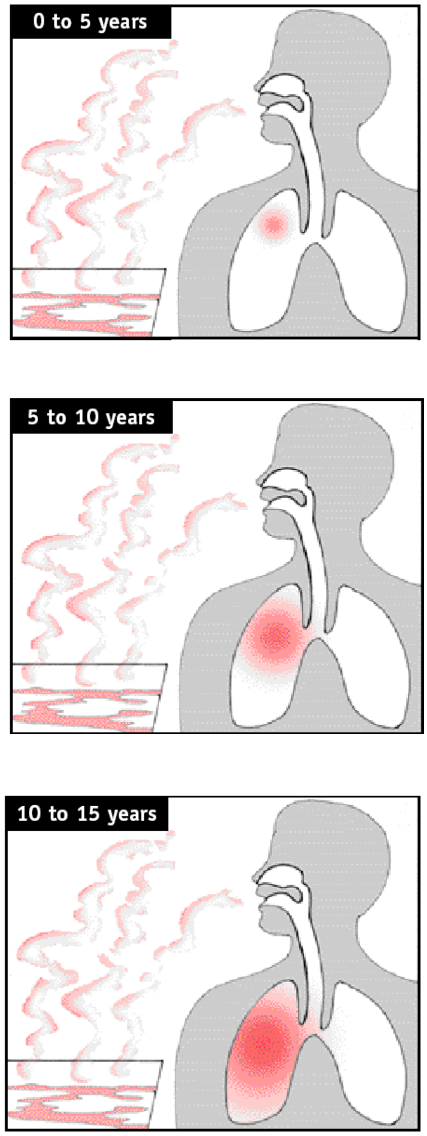


Figure 17: A teratogen is a chemical product that causes congenital defects (in the new born) e.g. Dimethyl mercury)

Some important numerical data associated with descriptive human toxicological information are the **Threshold Limit Values**. These are airborne limits of permitted concentrations of hazardous chemicals representing conditions under which it is believed that workers may be repeatedly exposed without adverse effects. These limits are subject to periodic revision and vary between different countries. The term **Threshold Limit** relates primarily to the U.S.A., but equivalent terms are available in most industrialised countries. Threshold limits are expressed in milligrams per cubic metre (mg/m^3) parts per million (ppm) or milligrams per litre (mg/l). Conversion from "ppm to "mg/l" can be done according to the formula:

$$mg/l = \frac{ppm \times mol.\ wt.}{24 \times 1000}$$

Common U.S. threshold limit values quoted for chemicals are:

a) The **Threshold Limit-Time Weighted Average (TLV-TWA)** which is a workplace value used as a guide for the maximum safe exposure to a chemical for a normal 8-hour working day and 40-hour working week. This is also called the **Maximum Allowable Concentration (MAC)**. In situations where the odour threshold for a particular substance is known to be above the TLV-TWA, the area should be ventilated or may even have to be evacuated if an odour is detected.

b) The **Threshold Limit-Short-Term Exposure Limit (TLV-STEL)** which is a workplace value similar in origin and meaning to the TLV-TWA except that this is the maximum concentration to which workers can be continuously exposed for a period up to 15 minutes without suffering irritation or chronic and irreversible effects provided that no more than four of these exposures occur per day and that there is at least 1 hour between exposure periods and that TLV-TWA is not exceeded (as an average).

c) The **Threshold Limit-Ceiling Values (TLV-C)** which is the concentration that should not be exceeded during any part of the working day.

After identification of the substance or substances has taken place the TLVs can provide a segment of the needed information to assess a hazardous situation. It must be noted that the TLVs alone are insufficient for a thorough evaluation and should not be used as a fine line between determining safe and dangerous environments.

Other numerical toxicological values often quoted in a Safety Data Sheet are:

a) **The Immediately Dangerous to Life or Health Value (IDLH)** which represents the maximum concentration from which one could escape within 30 minutes without irreversible health effects. However it should not be misinterpreted as a "safe" value and is used as a value for which air-supplied respiratory protection is required and at which filter or chemical cartridge protection would not be suitable. In fact a suggested "practical" definition of IDLH is the concentration at which irreversible effects on health could be expected.

b) The **Median Lethal Concentration (LC_{50})** which is a calculated (estimated) value of a substance in air, which causes death in 50% of the test population in a specified time.

c) The **Median Lethal Dose (LD_{50})** which is the calculated (estimated) value of a substance (in grams of substance per kilogram of body weight) that causes the death of 50% of the test population in specified time. It must be noted that the value obtained depends on the mode of administration e.g. oral, skin contact, intraperitoneal, subcutaneous and intravenous so that the route of administration must also accompany the data given for the value to have a useful meaning.

Since there is no widely accepted procedure for the selection of an appropriate exposure limit for general populations exposed to toxic vapours or gases, particularly where the limit is to be used in determining safe distances during evacuation, the following suggestions (**to be considered only as rough guidelines**) can be used to an adequately "safe" answer for most members of a community to be evacuated:

1) Consult a toxicologist or similarly qualified individual who will advise based on a formal review of the toxicity of the material.

2) Use the highest value among the following:

   - IDLH value divided by 10 (with "10" being a safety factor);
   - TLV-STEL;
   - TLV-TWA multiplied by 3 (if a TLV-STEL does not exist);
   - TLV-C.

3) If the evacuation of additional areas is not a problem, or the exposure may be prolonged beyond one hour, use the TLV-TWA or the TLV-C value or apply an additional safety factor to other selected threshold limit values.

It must be noted that the chronic exposure limits for substances known or suspected to be carcinogens are usually set at very low levels to protect workers form developing cancer during their lifetimes. Such values are generally many times (possibly several hundred times) lower than the limits enforced for the same materials prior to the discovery of their potential to induce cancer. Obviously, the size of the evacuation or hazard zone would be many times larger and the difference in the numbers of people that may require evacuation or other protective action may differ by thousands if not tens of thousands in urban areas.

Although, there is no hard evidence that a single exposure to a substance will cause excess cancers in a population of exposed humans, some health professionals prefer to err on the side of caution and are of the opinion that any exposure might lead to at least a minor increased risk of such cancers. This reasoning poses a dilemma during planning for evacuations, especially given the fears that may naturally accompany the announcement that a cancer-causing agent has been released into the atmosphere. It is therefore necessary to consider cases involving carcinogens carefully and on a case-by-case basis, giving full attention to the safety issues involving large-scale evacuations as well as the potential long-term health, political and legal implications of the decision.

8. FIRST AID MEASURES

In the event of over-exposure or accidental contact with the spilled chemical the first section that should be consulted in a Safety Data Sheet is that on **first-aid measures**. In a minor incident, standard first-aid procedures may be all that is needed and the section recommends first-aid treatment for accidental exposure after inhalation, after contact with skin and the eye and after ingestion.

In most cases, the suggestions for treatment of skin and eye exposure are standard, i.e., "immediately flush eye or skin with plenty of water for at least 15 minutes."

Recommendations for inhalation exposure are also usually standard, i.e., "remove to fresh air, if not breathing, give artificial respiration, if breathing is difficult, give oxygen."

The first aid treatment for ingestion does vary. Although inducing vomiting would be thought to be the standard response, in many cases, this could result in greater respiratory damage than that caused by ingestion. Often times, an antidote may be listed.

9. ECO TOXILOGICAL INFORMATION

Maritime transport of chemicals also involves a certain risk for the marine environment and, in case of a shipping accident, hazardous cargo may leak into the sea. Depending on its amount and its chemical, physical and eco-toxicological properties, a spilled chemical may threaten marine life over a wide area and over a certain period of time. Some Safety Data Sheets also contain eco-toxicological information that can be used to evaluate the hazards of a spilled chemical on marine living resources. Of use is information on **biodegradability, acute toxicity on biota**, and **bioaccumulation**. In most cases the information is based on evidence collected form laboratory tests.

Biodegradability is not a standard parameter with a well-defined endpoint nevertheless test procedures for assessing the biotic degradability of chemicals in surface waters have been developed which rely on the adaptive mutational capacity of bacteria. The biodegradation of a substance is assessed via the primary degradation/mineralization of the substance, during a 28-day test by measuring:

- the oxygen demand from micro-organisms (BOD); or
- the chemical oxygen demand (COD); or
- the carbon dioxide produced (CO_2 production); or
- the dissolved organic carbon content (DOC).

A substance could be considered to be "readily biodegradable" if the data listed in a Safety Data Sheet shows that there is;

- > 70% COD or DOC removal during 28 days;
- > 60% oxygen depletion or carbon dioxide during 28 days incubation;
- the ratio of BOD_5/COD > 0.5.

Other "convincing scientific evidence" may be available in a Safety Data Sheet to indicate that the substance is degraded (biologically and/or abiotically) in which case a careful evaluation of the data by scientific personnel is necessary to determine whether the substance will ultimately degrade in the marine environment.

For acute toxicity, the most common parameters quoted in a Safety Data Sheet are the **Median Lethal Concentration (LC_{50})** which is the estimated concentration in water at which 50% of the test population die during a specified period usually 48 or 96 hours and the **Median Tolerance Limit (TLm)** which is the estimated concentration in water at which 50% of the test population will show abnormal behaviour including death (the **Effective Concentration**-EC_{50} is sometimes used instead of the TLm).

The lower the LC_{50} or TLm the more toxic is the product. The rating scheme below developed by GESAMP might be used as a relative guidance as to the significant of LC_{50} values.

		DAMAGE TO LIVING RESOURCES
Ratings	Description	Criteria for LC_{50} (mg/l)
6	Extremely toxic	less than 0.01
5	Very highly toxic	0.01 – 0.1
4	Highly toxic	0.1 – 1
3	Moderately toxic	1-10
2	Slightly toxic	10-100
1	Practically non-toxic	100-1000
0	Non-toxic	Greater than 1000

It must be emphasized that in the above scheme the concentration bands selected do not mean that under other circumstances a substance with a 96-hr LC_{50} above 1000mg/l would not be harmful. However, it is considered that if the 96-hr LC_{50} exceeds 1000mg/l then it is unlikely to pose a significant hazard to marine organisms.

The interpretation of the significance of a LC_{50} value for a particular chemical should be done with care since this value is usually obtained under laboratory conditions and the problem of extrapolation from the laboratory to the environment always exists. Furthermore, one should be aware that for the same species, different stages of the life cycle of an organism are more sensitive than others and differences in inter-species sensitivity also exists. Consideration should also be given to fact that from an eco-toxicological aspect a 50% mortality, the predicted consequence of the release at the LC_{50} concentration, is quite naturally judged as an unacceptable effect of a spilled chemical. However, in the absence of a more elaborate scheme together with the fact that acute toxicity data are available for a large number of chemicals, the above given scheme although rather simple is probably the best means of hazard ranking and giving some kind of environmental significance to LC_{50} values.

For **bioaccumulation**, the **bio-concentration factor (BCF)** is a good indication of the bio accumulative potential of a substance (organic). A surrogate for the BCF, when this is not available, is the log P_{OW} which is the logarithm to the base 10 of the partition coefficient between n-octanol (which represents the fatty tissues of fish) and water. The partition coefficient is denoted by $K_{ow.}$

The rating scheme below developed by GESAMP may be used for guidance as to the significance of BCF/log POW values.

Rating	Description	Criteria for log POW	Criteria for BCF
0	No potential to bioaccumulate	♦ *<1, or* ♦ *>ca. 7, or* ♦ *Mol. Wt.>1000*	*no measurable BCF*
1	Very low potential to bioaccumulate	1 - <2	1 - <10
2	Low potential to bioaccumulate	2 - <3	10 - <100
3	Moderate potential to bioaccumulate	3 - <4	100 - <500
4	High potential to bioaccumulate	4 - <5	500 - <4000
5	Very high potential to bioaccumulate	>5	>4000

10. PREVENTION MEASURES

A Safety Data Sheet will also contain additional information which loosely would be considered to fall under the category of **preventive measures**. This information will be found in various sections of a Safety Data Sheet and will provide operational advice for the protection of the health of personnel exposed to a chemical under either accidental conditions or under conditions of normal handling and use. It will include measures on how to handle the chemical safety, the type of protective equipment and clothing required, give ventilation advice, what to do in the event of a spill or leak, safe disposal of spilled and chemical waste, the dangers of the chemical catching fire and the special measures for fighting a fire or an explosion.

11. USE OF INTERNET FOR CHEMICAL INFORMATION RETRIEVAL

The advent of new technology in desktop and portable computers has also heralded the arrival of spill-oriented software in particular computerized databases on chemical products. Furthermore the advent of the Internet has made information more accessible. This also includes information on chemical products. Most of these sites are intended for occupational health and safety application but may also contain essential spill response information. **Annex IV** lists a selection of web sites that can be consulted and are commonly used by REMPEC as sources of information on chemical data. It must be kept in mind however that for the most part these have been designed for other purposes besides spill response. Furthermore, during a spill situation, responders require rapidly basic information about the properties of the spilled substance. Consulting a good spill manual may sometimes be faster than searching and retrieving information on a chemical product using the Internet.

12. CONCLUSION

In conclusion, before one reads a Safety Data Sheet, one must be familiar with the type of information available in the sheet, and be accustomed to the meaning of some basic terminology together with its implications. Finally, it is recommended that the information obtained from this type of data source is compared with observations made at the scene of the incident to ensure that no mistake has been made as to the identity of the spilled material. If need be chemical analysis should be carried out.

ANNEX I

EXAMPLES OF SAFETY DATE SHEETS FROM DIFFERENT INFORMATION AVAILABLE AT REMPEC

1. Safety Data Sheet for Anhydrous Ammonia published by the Commission de la Santé et de la Securité du Travail (Canada)

2. International Chemical Safety Card for 1-Butanol published by the International Programme on Chemical Safety (Switzerland)

3. Safety Data Sheet for Hydrochloric Acid published by Environment Canada (Canada)

4. Response Information Data Sheet for Formic Acid published by the U.S. Coast Guard (USA)

ANNEX I

1. SAFETY DATE SHEET FOR ANHYDROUS AMMONIA

Toxicological data

Acute human toxicity

Ammonia in the form of a gas is irritating and corrosive for:
- the skin: irritation
- the eyes: watering, burning sensation in eye, damage to corneas
- the upper respiratory tract (nose and throat): drying out of the nose, coughing, pains in chest, shortness of breath, suffocation.

In serious cases, laryngeal oedema can be observed, evolving towards pulmonary oedema and death by asphyxiation. The appearance of symptoms may take up to 48 hours after exposure. Exposure to high concentrations causes bronchial irritation, but may also lead to corrosion of the skin, eyes and upper respiratory tract. Direct contact with the liquefied gas causes corrosion of the eyes and skin.

Probable acute effects due to accidental exposure depend on the dose of gas.

Chronic human toxicity

Repeated or prolonged exposure can create a certain tolerance, i.e. the irritating effects are detected at higher levels.

Threshold toxicological values

Occupational exposure values

MEV (France): 7 mg/m³ = 10 ppm
ELV (France): 14 mg/m³ = 20 ppm
TLV-TWA (ACGIH): 17 mg/m³ = 25 ppm

Risk management values for the population

IDLH (NIOSH): 210 mg/m³ = 300 ppm
TLV-STEL (ACGIH): 24 mg/m³ = 35 ppm
TEEL 0: 17.5 mg/m³ = 25 ppm
ERPG 1: 17.5 mg/m³ = 25 ppm
ERPG 2: 105 mg/m³ = 150 ppm
ERPG 3: 525 mg/m³ = 750 ppm

Specific effects

Effects on reproduction: no data available.
Carcinogenic effects: no carcinogenic effects according to the IARC.
Mutagenic effects: not mutagenic (Ames test with and without metabolic activation).

Ecotoxicological data

Acute ecotoxicity:
Crustacean (*Daphnia magna*)
LC_{50} (48h) = 25.4 mg/L (fresh water)
Crustacean (*Ceriodaphnia reticulata*)
LC_{50} (48h) = 131 mg/L (fresh water)
Fish (*Sciaenops ocellata*)
LC_{50} (24h) = 0.9 mg/L (seawater)
Fish (*Carassius auratus*)
LC_{50} (24h) = 7.2 mg/L (fresh water)
Fish (*Cyprinus carpio*)
LC_{50} (96h) = 1.1 mg/L (fresh water)

Chronic ecotoxicity:
Fish (*Ictalurus punctatus*)
NOEC (27 d) = 0.06 mg/L (fresh water)
Crustacean (*Ceriodaphnia dubia*)
NOEC reproduction (3 generations) = 2 mg/L (fresh water)
NOEC survival (3 generations) = 6.8 mg/L (fresh water)
PNEC (Predicted No-Effect Concentration): No PNEC can be established from the data obtained on only two trophic levels (invertebrates and fish). No valid data on algae is available in the literature.

Persistence in the environment

Ammonia is present in its natural state in the environment. It is a product of the biological breakdown of nitrogen-containing matter, such as amino acids. Ammonia is also a natural compound, required by most organisms for protein synthesis; it is a waste product of metabolism in animals, fish and microbes.

Risk for the environment

Ammonia is toxic for aquatic species. Its toxicity heavily depends on the PH of the water and the total ammonia concentration, i.e. that of the non-ionised ammonia: NH_3 and the ammonium ion: NH_4^+. The ionised form NH_4^+ predominates in most natural waters and is not very toxic. However, in alkaline waters, non-ionised ammonia NH_3 can reach toxic levels. This toxicity increases with the salinity and temperature.

Breakdown

In the ground: ammonia exists in the form of NH_4^+ ammonium ions. These ions can be immobilised in the ground and undergo nitrification, i.e. a transformation into NO_2^- then NO_3^- nitrites, more mobile than NH_4^+ ions. They can be carried into underground water reservoirs by washing, or react with organic matter.

In water: ammonia is eliminates from the water system by evaporation, transformation into NH_4^+ which undergoes nitrification into NO_2^- then NO_3^- or by adsorption onto particles in suspension.
In air: part of the ammonia is oxidised to form nitrogen oxides and nitrates. The rest combines with sulphates present in the atmosphere. The ammonia remains in the atmosphere for 5 to 10 days.

Bioaccumulation

Ammonia is continually produced in the environment either directly by organisms which give it off (some fish for instance) or indirectly through the breakdown of proteins excreted by these organisms.
The environment is used to managing this molecule, which many bacteria are specialised in eliminating. Consequently, this inorganic molecule is not found in the environment and is neither persistent nor bioaccumulable.

Partition coefficient for organic carbon and water (Koc): N/A
Partition coefficient for octanol and water (Kow): -1.14 at 25°C
Bioconcentration factor (BCF): N/A

MARPOL classification: N/A
SEBC Classification: GD

Particular risks

Danger

- Releases of ammonia present different characteristics according to the physical storage conditions and the type of spill:

• **Sudden release of ammonia gas from a pressurised container (discharge of the gaseous part)**: due to its high volatility (Henry's law constant: 1.6×10^{-5} atm.m³/mole), ammonia gas will spread over the water surface or the ground and will initially form a cloud of vapours. In air, the gas will behave like a heavy gas, despite its relative density of 0.6. This can be explained by the formation of an aerosol at low temperatures, made up of liquid or droplets in suspension in a gaseous environment. The gas mixture, under the influence of environmental conditions, will rise and by moved around by the wind.

• **Sudden release of ammonia in biphasic form (gas and liquid) from a pressurised container (discharge of the liquid part)**: production of a gas and an aerosol, in the form of a cold, white plume, heavier than air. It behaves like a heavy gas and can travel several hundred metres just above the ground surface. If the source of leakage is stopped, the aerosol will completely dissipate after a few minutes. The cloud of ammonia is relatively cold and causes the water vapour it meets on its journey to condense until the plume is warmed by dilution with the air. The cloud moves at wind speed and after complete vaporisation the gas becomes lighter than air and disperses.

• **Evaporation of a pool of liquid ammonia (according to conditions of release)**: ammonia is depressurised at atmospheric pressure and at temperatures lower than or equal to -33°C, and chills surrounding materials (for instance the ground). Evaporation is initially high and gradually decreases. Dry, porous ground will absorb liquid ammonia without releasing gases. Water should not be poured over a pool of ammonia, as the heat of the water and the dissolving action will trigger a high level of evaporation.

• **Leak of liquid ammonia from a cold storage facility**: the behaviour of the product is identical to that of the previous case; the leaked ammonia will be subject to little depressurisation and most often only a negligible proportion of the ammonia which escapes will be transformed into vapours.

- When ammonia gas dissolves in water, heat is released.
- When a receptacle containing ammonia is heated, there is an increase in pressure leading to a risk of the container bursting and immediately releasing a cloud of toxic vapours.
- Rapid depressurisation of a container can present a danger by producing a shock wave.
- When burnt, ammonia can give off toxic or irritating fumes.
- Direct contact with liquefied ammonia can cause frostbite and serious ocular lesions.
- Pierced gas canisters can propel themselves violently.
- Ammonia in the form of liquefied gas rapidly attacks copper, zinc, silver and tin, as well as many alloys, particularly those containing copper. It also acts on gold, silver and mercury to produce explosive compounds.

Stability and reactivity

At ordinary temperatures, ammonia gas is a stable compound.
Conditions to be avoided: breaks down at over 450°C to produce nitrogen and hydrogen.
Substances to be avoided: mineral or organic acids, reactive metals and metalloids (calcium, sodium, zinc, mercury...), oxidants and peroxides due to the violent and/or explosive reactions caused.

Transportation

General data:
Class: 2
Toxic gas & Corrosive
Labels: 2.3 + 8

Land transportation: RID / ADR
Hazard classification: 268
Classification code: 2TC

Transportation via inland waterways: ADN/ADNR
Classification code: 2TC

Maritime and air transportation: IMDG/IATA
Marine pollutant (MP): No
Subsidiary risk: 8

Handling

- Refer to supplier's instructions for information on handling container.
- Only use specialised equipment suitable for this product and its pressure and temperature. Contact the ammonia supplier if there is any doubt.
- Prevent the product from rising up in the container.
- Prevent suction of water into the container.
- Keep away from all sources of ignition (including static charges).
- Purge the air in the installation before introducing the gas.
- Always handle pressurised canisters with care, do not drag or slide them across the ground and prevent blows.

Storage

Technical precautions

- Store containers in a well ventilated place, at a temperature lower than 50°C.
- Keep away from oxidising gases and other oxidising agents.
- Store the containers vertically, out of direct sunlight and away from heat and products liable to react violently with the ammonia. The containers should be tightly closed and clearly labelled.
- Store on impermeable ground with a retention tank so that in the event of a spill the solutions do not spread outside the storage facility.
- Ground the tanks and ensure that the electric wiring is watertight.
- Do not smoke.

Incompatible products

Non ferrous metals (copper, zinc, tin, silver) and their alloys.

Recommended packaging materials

Bulk transportation: carbon steel/stainless steel.
Gas canisters: stainless steel except type T1.

2. INTERNATINAL CHEMICAL SAFETY CARD FOR 1 BUTANOL

International Chemical Safety Cards

1-BUTANOL

ICSC: 0111

n-Butanol
n-Butyl alcohol
Propyl carbinol
Butan-1-ol
Butyl alcohol
$C_4H_{10}O$ / $CH_3(CH_2)_3OH$
Molecular mass: 74.1

ICSC # 0111
CAS # 71-36-3
RTECS # EO1400000
UN # 1120
EC # 603-004-00-6
April 19, 2005 Validated

TYPES OF HAZARD/ EXPOSURE	ACUTE HAZARDS/ SYMPTOMS	PREVENTION	FIRST AID/ FIRE FIGHTING
FIRE	Flammable.	NO open flames, NO sparks, and NO smoking.	Powder, water spray, foam, carbon dioxide.
EXPLOSION	Above 29°C explosive vapour/air mixtures may be formed.	Above 29°C use a closed system, ventilation, and explosion-proof electrical equipment.	In case of fire: keep drums, etc., cool by spraying with water.
EXPOSURE			
•INHALATION	Cough. Sore throat. Headache. Dizziness. Drowsiness.	Ventilation, local exhaust, or breathing protection.	Fresh air, rest.
•SKIN	Redness. Pain. Dry skin.	Protective gloves.	Remove contaminated clothes. Rinse skin with plenty of water or shower.
•EYES	Redness. Pain.	Safety goggles.	First rinse with plenty of water for several minutes (remove contact lenses if easily possible), then take to a doctor.
•INGESTION	Abdominal pain. Drowsiness. Dizziness. Nausea. Diarrhoea. Vomiting	Do not eat, drink, or smoke during work.	Rinse mouth. Give plenty of water to drink. Do NOT induce vomiting. Refer for medical attention.

SPILLAGE DISPOSAL	STORAGE	PACKAGING & LABELLING
Personal protection: filter respirator for organic gases and vapours.	Fireproof. Separated from strong oxidants, aluminium.	Xn symbol

Collect leaking liquid in sealable containers. Absorb remaining liquid in sand or inert absorbent and remove to safe place. Wash away remainder with plenty of water.	R: 10-22-37/38-41-67 S: 2-7/9-13-26-37/39-46 UN Hazard Class: 3 UN Packing Group: III

SEE IMPORTANT INFORMATION ON BACK

ICSC: 0111	Prepared in the context of cooperation between the International Programme on Chemical Safety & the Commission of the European Communities (C) IPCS CEC 1994. No modifications to the International version have been made except to add the OSHA PELs, NIOSH RELs and NIOSH IDLH values.

International Chemical Safety Cards

1-BUTANOL

ICSC: 0111

IMPORTANT DATA	**PHYSICAL STATE; APPEARANCE:** COLOURLESS LIQUID , WITH CHARACTERISTIC ODOUR. **PHYSICAL DANGERS:** **CHEMICAL DANGERS:** Reacts with aluminium when heated to 100°C, strong oxidants , such as chromium trioxide forming flammable/explosive gas (hydrogen - see ICSC0001). Attacks some forms of plastic, rubber and coatings. **OCCUPATIONAL EXPOSURE LIMITS:** TLV: 20 ppm as TWA; (ACGIH 2005). MAK: 100 ppm, 310 mg/m³; Peak limitation category: I(1); Pregnancy risk group: C; (DFG 2004). OSHA PEL†: TWA 100 ppm (300 mg/m³) NIOSH REL: C 50 ppm (150 mg/m³) skin NIOSH IDLH: 1400 ppm 10%LEL See: 71363	**ROUTES OF EXPOSURE:** The substance can be absorbed into the body by inhalation of its vapour and by ingestion. **INHALATION RISK:** A harmful contamination of the air will be reached rather slowly on evaporation of this substance at 20°C. **EFFECTS OF SHORT-TERM EXPOSURE:** The substance is irritating to the skin , and is severely irritating to the eyes . The vapour is irritating to the eyes and the respiratory tract. Exposure far above the OEL could cause lowering of consciousness. If this liquid is swallowed, aspiration into the lungs may result in chemical pneumonitis. **EFFECTS OF LONG-TERM OR REPEATED EXPOSURE:** The liquid defats the skin.
PHYSICAL PROPERTIES	Boiling point: 117°C Melting point: -90°C Relative density (water = 1): 0.81 Solubility in water, g/100 ml at 20°C: 7.7 Vapour pressure, kPa at 20°C: 0.58 Relative vapour density (air = 1): 2.6	Relative density of the vapour/air-mixture at 20°C (air = 1): 1.01 Flash point: 29°C c.c. Auto-ignition temperature: 345°C Explosive limits, vol% in air: 1.4-11.3 Octanol/water partition coefficient as log Pow: 0.9
ENVIRONMENTAL DATA		

NOTES

Transport Emergency Card: TEC (R)-30S1120-III

NFPA Code: H1; F3; R0;

ADDITIONAL INFORMATION

ICSC: 0111 1-BUTANOL

IMPORTANT LEGAL NOTICE:	Neither NIOSH, the CEC or the IPCS nor any person acting on behalf of NIOSH, the CEC or the IPCS is responsible for the use which might be made of this information. This card contains the collective views of the IPCS Peer Review Committee and may not reflect in all cases all the detailed requirements included in national legislation on the subject. The user should verify compliance of the cards with the relevant legislation in the country of use. The only modifications made to produce the U.S. version is inclusion of the OSHA PELs, NIOSH RELs and NIOSH IDLH values.

3. SAFETY DATA SHEET – HYDROCHLORIC ACID

Material Safety Data Sheet — Page 1 of 2

Hydrochloric Acid Solution, 3.0M

MSDS # 332.00

ScholAR Chemistry

Section 1:	**Product and Company Identification**

Hydrochloric Acid 3.0M

Synonyms/General Names: Muriatic Acid; Hydrochloric Acid Solution, 3N
Product Use: For educational use only
Manufacturer: Columbus Chemical Industries, Inc., Columbus, WI 53925.

24 Hour Emergency Information Telephone Numbers

CHEMTREC (USA): 800-424-9300 — **CANUTEC (Canada): 613-424-6666**

ScholAR Chemistry; 5100 W. Henrietta Rd, Rochester, NY 14586; (866) 260-0501; www.Scholarchemistry.com

Section 2:	**Hazards Identification**

Clear colorless liquid; pungent odor.

WARNING! Strongly corrosive to body tissue and moderately toxic by ingestion.
Target organs: Respiratory system, eyes, skin, lungs.

HMIS (0 to 4)

Health	2
Fire Hazard	0
Reactivity	1

This material is considered hazardous by the OSHA Hazard Communication Standard (29 CFR 1910.1200).

Section 3:	**Composition / Information on Ingredients**

Hydrochloric Acid, 37% (7647-01-0), 28%. Water (7732-18-5), 72%.

Section 4:	**First Aid Measures**

Always seek professional medical attention after first aid measures are provided.

Eyes: Immediately flush eyes with excess water for 15 minutes, lifting lower and upper eyelids occasionally.
Skin: Immediately flush skin with excess water for 15 minutes while removing contaminated clothing.
Ingestion: Call Poison Control immediately. ***Do not induce vomiting***. Rinse mouth with cold water. Give victim 1-2 cups of water or milk to drink.
Inhalation: Remove to fresh air. If not breathing, give artificial respiration.

Section 5:	**Fire Fighting Measures**

When heated to decomposition, emits acrid fumes.
Protective equipment and precautions for firefighters: Use foam or dry chemical to extinguish fire. Firefighters should wear full fire fighting turn-out gear and respiratory protection (SCBA). Cool container with water spray. Material is not sensitive to mechanical impact or static discharge.

Section 6:	**Accidental Release Measures**

Use personal protection recommended in Section 8. Isolate the hazard area and deny entry to unnecessary and unprotected personnel. Remove all ignition sources and ventilate area. Contain spill with sand or absorbent material and place material in a sealed bag or container for disposal. Wash spill area after pickup is complete. See Section 13 for disposal information.

Section 7:	**Handling and Storage**	**White**

Handling: Use with adequate ventilation and do not breathe dust or vapor. Avoid contact with skin, eyes, or clothing. Wash hands thoroughly after handling.
Storage: Store in Corrosive Area [White Storage] with other corrosive items. Store in a dedicated corrosive cabinet. Store in a cool, dry, well-ventilated, locked store room away from incompatible materials.

Section 8:	**Exposure Controls / Personal Protection**

Use ventilation to keep airborne concentrations below exposure limits. Have approved eyewash facility, safety shower, and fire extinguishers readily available. Wear chemical splash goggles and chemical resistant clothing such as gloves and aprons. Wash hands thoroughly after handling material and before eating or drinking. Use NIOSH-approved respirator with an acid/organic cartridge. Exposure guidelines Hydrochloric Acid: OSHA PEL: 5 ppm ceiling and ACGIH TLV: 2 ppm ceiling, STEL: N/A.

 12/20/2011

4. SAFETY DATA SHEET – FORMIC ACID

FORMIC ACID	FMA

9.20 SATURATED LIQUID DENSITY	
Temperature (degrees F)	Pounds per cubic foot
50	76.650
55	76.450
60	76.240
65	76.030
70	75.820
75	75.610
80	75.410
85	75.200
90	74.990
95	74.780
100	74.570

9.21 LIQUID HEAT CAPACITY	
Temperature (degrees F)	British thermal unit per pound-F
70	0.511
80	0.515
90	0.518
100	0.522
110	0.526
120	0.530
130	0.534
140	0.538
150	0.542
160	0.546
170	0.550
180	0.553
190	0.557
200	0.561
210	0.565

9.22 LIQUID THERMAL CONDUCTIVITY	
Temperature (degrees F)	British thermal unit inch per hour-square foot-F
55	1.905
60	1.904
65	1.902
70	1.901
75	1.899
80	1.898
85	1.896
90	1.894
95	1.893
100	1.891
105	1.890
110	1.888
115	1.886
120	1.885
125	1.883
130	1.882
135	1.880
140	1.879
145	1.877
150	1.875
155	1.874
160	1.872
165	1.871
170	1.869
175	1.868
180	1.866

9.23 LIQUID VISCOSITY	
Temperature (degrees F)	Centipoise
	NOT PERTINENT

9.24 SOLUBILITY IN WATER	
Temperature (degrees F)	Pounds per 100 pounds of water
	MISCIBLE

9.25 SATURATED VAPOR PRESSURE	
Temperature (degrees F)	Pounds per square inch
40	0.268
50	0.365
60	0.491
70	0.652
80	0.858
90	1.117
100	1.441
110	1.842
120	2.335
130	2.936
140	3.663
150	4.539
160	5.584
170	6.825
180	8.290
190	10.010
200	12.020
210	14.350

9.26 SATURATED VAPOR DENSITY	
Temperature (degrees F)	Pounds per cubic foot
40	0.00230
50	0.00307
60	0.00405
70	0.00528
80	0.00681
90	0.00871
100	0.01104
110	0.01386
120	0.01727
130	0.02135
140	0.02620
150	0.03192
160	0.03864
170	0.04648
180	0.05557
190	0.06607
200	0.07811
210	0.09187

9.27 IDEAL GAS HEAT CAPACITY	
Temperature (degrees F)	British thermal unit per pound-F
0	0.214
25	0.221
50	0.228
75	0.234
100	0.240
125	0.247
150	0.253
175	0.259
200	0.265
225	0.271
250	0.277
275	0.282
300	0.288
325	0.294
350	0.299
375	0.304
400	0.309
425	0.314
450	0.319
475	0.324
500	0.329
525	0.334
550	0.338
575	0.343
600	0.347

JUNE 1999

ANNEX II

THE PHONETIC ALAPHABET

The following phonetic alphabet may be used when communicating to ensure accurate spelling of product name(s).

A Alfa	N November
B Bravo	O Oscar
C Charlie	P Papa
D Delta	Q Quebec
E Echo	R Romeo
F Foxtrot	S Sierra
G Golf	T Tango
H Hotel	U Uniform
I India	V Victor
J Juliet	W Whiskey
K Kilo	X X-Ray
L Lima	Y Yankee
M Mike	Z Zulu

Example

Ethyl mercaptan would be spelled out in the following manner:

E Echo	**M** Mike
T Tango	**E** Echo
H Hotel	**R** Romeo
Y Yankee	**C** Charlie
L Lima	**A** Alfa
	P Papa
	T Tango
	A Alfa
	N November

ANNEX III

UNITED NATIONS CLASSIFICATION, DEFINITIONS OF CLASSES OF DANGEROUS GOODS AND ASSOCIATED LABELS

Hazardous diamonds

Classification	Hazard warning sign	Classification	Hazard warning sign
Explosive substance Class 1		Flammable gas Class 2.1 **	
Non-flammable, non-toxic gas Class 2.2 **		Toxic gas Class 2.3	
Flammable liquid Class 3 **		Flammable solids, self-reactive substances and solid desensitized explosives Class 4.1	
Substances liable to spontaneous combustion Class 4.2		Substance which in contact with water emit flammable gas Class 4.3 **	

Hazardous diamonds

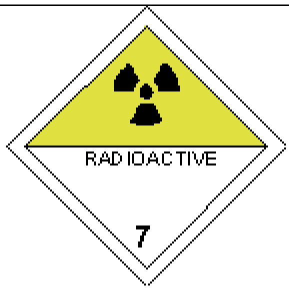
<table>
<tr><td>Oxidizing substances

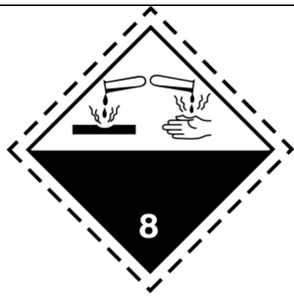
Class 5.1</td><td></td><td>Organic peroxides

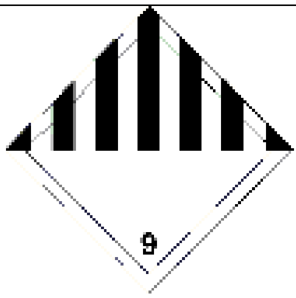
Class 5.2</td><td></td></tr>
<tr><td>Toxic substances

Class 6.1</td><td></td><td>Infectious substances

Class 6.2</td><td></td></tr>
<tr><td>Radioactive material

Class 7</td><td></td><td>Corrosive substances

Class 8</td><td></td></tr>
<tr><td>Other dangerous substances and articles

Class 9</td><td></td><td></td><td></td></tr>
</table>

ANNEX IV

A SELECTION OF WEBSITE CONTAINING CHEMICAL SAFETY DATE SHEETS

Web site	Data
http://siri.org	Links to 3 sites in Vermont, Florida and California, USA, each containing a collection of Safety Data Sheets and links to other sites providing chemical safety information
http://hazard.com/msds	Same as above
http://www.chemfinder.com	Database from Cambridge Soft Corporation; individual access to Chemfinder is complimentary on a limited basis; access by corporations, academic institutions and government organizations is granted on an enterprise subscription basis
http://www.fisher.co.uk/index.php/en/catalogues http://www.fishersci.com/ecomm/servlet/cmstatic?pagename=msds&&storeId=10652	Safety Data Sheets for Fisher-manufactured chemicals and ACROS Organics can be retrieved
http://www.chem.ac.ru/Chemistry/Databases/ECDIN.en.html	The Environment Chemicals Data and Information Network (ECDIN) is a factual database created under the Environmental Research Programme of the European Commission
http://msds.chem.ox.ac.uk/index2.html	Safety Information from the Physical and Theoretical Chemistry Laboratory of the Oxford University, U.K. – Safety Data Sheets, (5,047 entries, 12,228 synonyms)
http://www.etc-cte.ec.gc.ca/databases_e.html	A site of the Environmental Technology Centre of Environment Canada containing two links: one to a database on 431 oils and oil products; the other on chemical synonyms
http://response.restoration.noaa.gov/chemaids/react.html	Information on reactivity/compatibility of binary mixtures of chemical substances; Programme can be downloaded

ANNEX V

1. ENGLISH-FRENCH VOCABULARY OF SOME COMMON TERMS FOUND IN A MATERIAL DATA SHEET

ENGLISH	FRENCH
Identification and use of the product	Identification et utilisation du produit
Packaging and transportation of dangerous goods	Emballage et transport de matières dangereuses
Physicochemical Properties:	Propriétés physico-chimiques:
Chemical Formula	Formule chimique
Molecular Weight	Masse moléculaire
Physical State	Etat physique
Colour, Odour and Appearance	Couleur, odeur et apparence
Characteristics	Caractéristiques
Olfactory Identification Limit	Limite de détection olfactive
Density and Specific Gravity	Masse volumique et densité spécifique
Freezing Point	Point de solidification
Melting Point	Point de fusion
Boiling Point	Point d'ébullition
Vapour Pressure	Tension de vapeur
Vapour Density	Densité de vapeur
Evaporation Rate	Taux d'évaporation
Flash Point	Point d'éclair
Auto-Ignition Temperature	Température d'auto-ignition
Upper and Lower Flammable or Explosive Limit	Limites inférieure et supérieure d'inflammabilité ou D'explosibilité
Coefficient of Water/Oil Distribution	Coefficient de partage eau/huile
pH	pH
Solubility in Water	Solubilité dans l'eau
Granulometry	Granulmétrie
Stability	Stabilité
Incompatibility	Incompatibilité
Reactivity	Réactivité
Polymerization	Polymérisation
Decomposition Products	Produits de décompostion
TOXICOLOGICAL AND ECOTOXICOLOGICAL PROPERTIES	PROPRIETES TOXICOLOGIQUES ET ECOTOXICOLGIQUES
Routes of absorption	Voies d'absorption dans l'organisme
Toxic Effects	Effets toxiques
A – Acute Effects	A – Effets aigüs
B – Chronic Effects	B – Effets chroniques
Teratogenic Effect	Effet tératogène
Mutagenic Effect	Effet mutagène

Carcinogenic Effect	Effet cancérigène
Threshold limit value (TLV)	Teneur limite acceptable
Immediately dangerous to life or dangereuse	Teneur immédiatement
Health Value (IDLH)	Pour la vie ou la santé
Median lethal concentration (LC50)	Conentration létale médiane (CL50)
Median lethal dose (LD50)	Dose létale médiane (DL50)
Median tolerance limit (TLm)	Teneur limite tolérance

PREVENTION MEASURES | MESURES DE PREVENTION

Flammability	Inflammabilité
Explosivity	Explosibilité
Fire or Explosion	Feu ou explosion
Leaks or Accidents	Fuites ou accidents
Protective Equipment	Equipements de protection
Handling	Manipulation
Storage	Entreposage

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