

# Danger Symbols

**Danger symbols** are used for the labeling hazardous substances after the *Ordinance on Hazardous Substances*.

The *Ordinance on Hazardous Substances* is a regulation to safeguard versus hazardous substances and comprises primarily the field of occupational safety. The directions of the Ordinance on Hazardous Substances for the classification, packing, and labeling of chemicals are valid for all fields and areas and apply, therefore, also for environmental and consumer protection and human health.

The term *Hazardous Substances* is a generic name and is defined after the §19/2 of the *Chemicals Law* as

- Dangerous substances or formulations after §3a of the Chemicals Law,
- Substances, formulations, and products they may form or release dangerous substances or formulations during their production or use,
- Explosive substances, formulations, and products.

Following are some definitions to better understand these legal issues:

- **Substances** are chemical elements or compounds how they occur in nature or produced in a synthetic way (e.g., asbestos, bromine, ethanol, lead, etc.).
- **Formulations** are blends, mixtures, or solutions of two or more substances (e.g., diluting agents, paints, formaldehyde solutions, galvanic bathes).
- **Products** are substances or formulations which obtained a specific shape, surface, or form during the production process. These properties determine the function of the products more than their chemical composition (e.g., nickel containing welding electrodes, pine wood shelves, plastic tanks).

Hazardous substances defined above possess one or more properties marked with danger symbols.

**Danger symbols** are pictograms containing black signs on orange background. Danger categories for substances and formulations marked with danger symbols are subdivided in

- Risks of fire and explosion (physical-chemical properties),
- Health risks (toxicological properties), or
- Combination of these both.

Following, all danger symbols including their danger notation and code letters are explained. (Note: Code letters are not part of the danger symbols.)

## Inflammable Substances

*Inflammable substances* comprise the sub-groups *explosive substances*, *oxidizing substances*, *extremely flammable substances*, and *highly flammable substances*. *Flammable substances* belong also to the category of *inflammable substances*, but the use of a danger symbol is not necessary for these substances.

## Explosive



**Code Letter: E**

Substances and formulations marked with the danger notation “explosive” can explode by hit, friction, heating, fire, and other ignition sources even without atmospheric oxygen. Explosion will be triggered by a vigorous reaction of the substance. High energy is released thereby along with propagation of shock waves. The risk of explosion can be determined after the methods given in the *Law for Explosive Substances*.

In the laboratory mixtures of strongly oxidizing compounds with flammable or reducing substances can be explosive. For instance, fuming nitric acid reacts with an explosion with solvents like acetone, diethylether, ethanol, etc. Production or working with explosives necessitates particular knowledge and practical experiences as well as special safety measures. While working with these substances the quantities must be kept small for handling as well as for stockpiling.

The main *R-Phrases* for *explosive substances* are R1, R2, and R3.

An example for the above described properties is **2,4,6-trinitro toluene (TNT)**.

## Oxidizing



**Code Letter: O**

Substances and formulations marked with the danger notation “oxidizing” are usually not combustible. But in contact with combustible or highly flammable substances they can increase the risk and the violence of a fire significantly. In many cases they are salt-like inorganic substances with strongly oxidizing properties and organic peroxides.

The main *R-Phrases* for *oxidizing substances* are R7, R8, and R9.

Examples for the above described properties are **potassium chlorate** and **potassium permanganate**, but also **concentrated nitric acid**.

## Extremely Flammable



**Code Letter: F<sup>+</sup>**

Substances and formulations marked with the danger notation “extremely flammable” have as liquids a very low ignition points (below 0 °C) and low boiling points resp. initial boiling points (below + 35 °C). Extremely flammable gaseous substances easily form with air an explosive mixture under normal conditions.

The main *R-Phrase* for *extremely flammable substances* is R12.

Examples for the above described properties are **diethylether** (liquids) and **hydrogen** resp. **propane** (gases).

## Highly Flammable



**Code Letter: F**

Substances and formulations marked with the danger notation “highly flammable” are subject for self-heating and ignition under usual atmospheric conditions, or they have low ignition points (below + 21 °C). Some highly flammable substances produce extremely flammable gases under the influence of humidity. Substances they may heat up in air at room temperature without additional energy supply and finally ignite are also labeled as “highly flammable”.

The main *R-Phrase* for *highly flammable substances* is R11.

Examples for the above described properties are **acetone** and **sodium metal**, which are regularly used in laboratories as solvent resp. drying agent.

## Flammable

**Code Letter: not given**

There is no danger symbol needed in order to label substances and formulations with the danger notation “flammable”. Liquid substances and formulations having an ignition point between + 21 °C and + 55 °C are categorized as “flammable”.

The main *R-Phrase* for *flammable substances* is R10.

An example for the above described properties is **oil of turpentine**.

## Substances Hazardous to Health

The categorization of substances and formulations according to their toxicological properties comprises acute and long-term effects independent whether these effects are caused from one single, repeated, or long-term exposition. An important parameter to assess the acute toxicity of a substance is its  $LD_{50}$  value determined in animal experiments. The  $LD_{50}$  value reflects the lethal dose in mg per kg body weight which would cause the death of 50% of the test animals within 14 days after one single administration. Due to the test design one distinguishes between  $LD_{50}$  oral (p. o. = per os) uptake and digestion through the gastrointestinal system, and  $LD_{50}$  dermal in case of uptake through the skin. Besides these both there exists also a lethal concentration  $LC_{50}$  pulmonary (inhalation). It reflects the concentration of a pollutant in air (mg/L) which would cause death of 50% of the test animals within 14 days after an exposition of four hours.

The term “substances hazardous to health” includes the sub-groups “very toxic substances”, “toxic substances”, and “harmful substances”.

### Very Toxic



**Code Letter: T<sup>+</sup>**

Substances and formulations marked with the danger notation “very toxic” can cause significant acute or chronic health damages and even death at very low concentrations if taken up by inhalation, ingestion, or in contact with the skin.

A substance is categorized as very toxic if the following criteria of the Ordinance on Hazardous Substances are fulfilled:

|  |   |
|--|---|
| $LD_{50}$ oral (rat)                         | $\leq 25$ mg/kg b.w. (b.w. = body weight) |
| $LD_{50}$ dermal (rat or rabbit)             | $\leq 50$ mg/kg b.w.                      |
| $LC_{50}$ pulmonary (rat) for aerosols/dusts | $\leq 0.25$ mg/L                          |
| $LC_{50}$ pulmonary (rat) for gases/vapors   | $\leq 0.50$ mg/L                          |

The main *R-Phrases* for very toxic substances are R26, R27, and R28.

Examples for the above described properties are **potassium cyanide**, **hydrogen sulphide**, **nitrobenzene**, and **atropine** (the naturally produced alkaloid in *deadly nightshade*).

## Toxic



**Code Letter: T**

Substances and formulations marked with the danger notation “toxic” can cause acute or chronic health damages and even death at low concentrations if taken up by inhalation, ingestion, or in contact with the skin.

A substance is categorized as toxic if the following criteria of the Ordinance on Hazardous Substances are fulfilled:

|   |                     |
|---|---------------------|
| LD <sub>50</sub> oral (rat)                         | 25 – 200 mg/kg b.w. |
| LD <sub>50</sub> dermal (rat or rabbit)             | 50 – 400 mg/kg b.w. |
| LC <sub>50</sub> pulmonary (rat) for aerosols/dusts | 0.25 – 1 mg/L       |
| LC <sub>50</sub> pulmonary (rat) for gases/vapors   | 0.50 – 2 mg/L       |

The main *R-Phrases* for *toxic substances* are R23, R24, and R25.

Substances and formulations having the properties

|  |   |
|--|---|
| <b>carcinogenic</b>                          | (main <i>R-Phrases</i> : R45 and R40),    |
| <b>mutagenic</b>                             | (main <i>R-Phrase</i> : R47),             |
| <b>toxic for reproduction</b>                | (main <i>R-Phrases</i> : R46 and R40), or |
| <b>other chronically damaging properties</b> | (main <i>R-Phrase</i> : R48)              |

are marked with the danger symbol for “toxic substances” and the code letter T.

Carcinogenic substances can cause cancer or increase the cancer incidence if taken up by inhalation, ingestion, or in contact with the skin.

Examples for the above described properties are solvents like **methanol** (toxic) and **benzene** (toxic, carcinogenic).

## Harmful



**Code Letter: Xn**

Substances and formulations marked with the danger notation “harmful” have a moderate risk of health damages if taken up by inhalation, ingestion, or in contact with the skin.

A substance is categorized as harmful if the following criteria of the Ordinance on Hazardous Substances are fulfilled:

|   |                       |
|---|-----------------------|
| LD <sub>50</sub> oral (rat)                         | 200 – 2000 mg/kg b.w. |
| LD <sub>50</sub> dermal (rat or rabbit)             | 400 – 2000 mg/kg b.w. |
| LC <sub>50</sub> pulmonary (rat) for aerosols/dusts | 1 – 5 mg/L            |
| LC <sub>50</sub> pulmonary (rat) for gases/vapors   | 2 – 20 mg/L           |

The main *R-Phrases* for *harmful substances* are R20, R21, and R22.

Substances and formulations having the properties

|  |   |
|--|---|
| <b>carcinogenic</b>                          | (main <i>R-Phrases</i> : R45 and R40),    |
| <b>mutagenic</b>                             | (main <i>R-Phrase</i> : R47),             |
| <b>toxic for reproduction</b>                | (main <i>R-Phrases</i> : R46 and R40), or |
| <b>other chronically damaging properties</b> | (main <i>R-Phrase</i> : R48)              |

which are not notated as toxic, will be marked with the danger symbol for “harmful substances” and the code letter Xn.

Further substances, which are

**suspected to have carcinogenic properties,**

will also be marked with the danger symbol for “harmful substances” and the code letter Xn.

**Sensitizing substances** (main *R-Phrases*: R42 and R43)

are labeled according to their spectrum of effects either with the danger symbol for “harmful substances” and the code letter Xn or with the danger symbol for “irritant substances” and the code letter Xi.

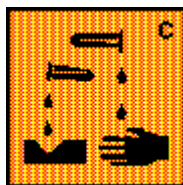
Substances suspected to have carcinogenic properties can cause cancer with high probability if taken up by inhalation, ingestion, or in contact with the skin.

Examples for the above described properties are solvents like **1,2-ethane-1,2-diol = ethylene glycol = glycol** (harmful) and **dichloromethane** (harmful, suspected to be carcinogenic).

## Tissue Destroying Substances

The term “tissue destroying substances” includes the sub-groups “corrosive substances” and “irritant substances”.

### Corrosive



**Code Letter: C**

Substances and formulations with the damage notation “corrosive” destroy living tissues. If a substance destroys the healthy and intact skin of test animals in its whole thickness or this property is predictable due to the chemical characteristics of the test substances, e.g., acids (pH < 2) and bases (pH > 11.5), then it will be marked as corrosive.

The main *R-Phrases* for *corrosive substances* are R34 and R35.

Examples for the above described properties are mineral acids like **hydrochloric acid** and **sulfuric acid** as well as bases like **sodium hydroxide solutions** (**caustic-soda solutions**) (> 2%).

## Irritant



**Code Letter: Xi**

Substances and formulations with the damage notation “irritant” are not corrosive. But they can cause inflammation in contact with skin or mucous membranes.

The main *R-Phrases* for *irritant substances* are R36, R37, R38, and R41.

Examples for the above described properties are **isopropyl amine**, **calcium chloride** and **diluted acids** and **bases**.

## Dangerous for the Environment Code Letter: N

### Dangerous for the Environment



**Code Letter: N**

Substances and formulations with the damage notation “dangerous for the environment” can cause immediate or delayed adverse effects on one or more environmental compartments (water, soil, air, plants, micro organisms) and lead to ecological disturbances.

The main *R-Phrases* for *environmentally hazardous substances* are R50, R51, R52, and R53.

Examples for the above described properties are **tributyl tin chloride**, **tetrachloro methane**, and petroleum hydrocarbons like **pentane** and **petroleum benzine**.