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Section on Prevention in the Chemical Industry

Ready to use hazardous substances?

Important steps to handle such chemicals safely

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Ready to use hazardous substances?

Important steps to handle such chemicals safely

VISION ZERO
Safety.Health.Wellbeing.

To build a strong prevention culture and to eliminate accidents at work and occupational diseases, the ISSA's "Vision Zero" concept is a transformational approach that integrates the three dimensions of safety, health and well-being at all levels of work. The ISSA has developed a range of resources to support the implementation of the Vision Zero Campaign in enterprises by following the seven golden rules www.visionzero.global.

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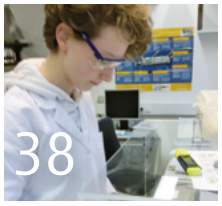

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Ready to use hazardous substances?

Preface

The "Dangerous Substances" Working Group of the ISSA Chemistry Section is concerned with current topics regarding chemical agents, and develops products that are designed to support enterprises, especially small and medium-sized enterprises (SME), in assessing hazards and developing appropriate protective measures. The range of topics include safe handling and storage of hazardous substances as well as transport of dangerous goods.

In this context it is very important to implement risk assessment as a key element of occupational health and safety in every company. This brochure explains the most relevant aspects when handling hazardous substances.

Thomas Köhler
President of the International Section of the ISSA on Prevention in the Chemical Industry

1 Introduction

Using hazardous chemical agents can lead to risks to the safety and health of workers, such as irritation, poisoning, and burns. Long-term effects, emanating, for example, by carcinogenic agents, can cause occupational diseases. Furthermore, chemical agents with physical hazards have the potential to cause accidents like fire and explosion. Chemical agents with hazards for the environment can constitute risks for aquatic life and the ozone layer.

If chemical agents are produced, used or released by any work activity like handling, storage, transport or disposal and treatment, employers have to identify and assess the risks for their employees as well as determine and implement protective measures. Giving an initial insight into the steps that need to be taken, this brochure supports the people in charge in companies by imparting knowledge with a particular focus on health hazards. National legislation needs to be taken into account in order to work out how to implement the complete risk assessment.

The brochure is addressed, in particular, to trained first-line supervisors or "foreworkers" in small and medium-sized enterprises and other persons who have to instruct employees on this topic and raise awareness about health hazards when in contact with chemicals.

Additionally, the ISSA Sections Electricity, Gas and Water; Iron and Metal Industry; as well as Machine and System Safety, have published a "Guide for Risk Assessment in Small and Medium Enterprises, #3 Chemical Hazards: Identification and Evaluation of Hazards; Specification of Measures." This brochure is part of a series which represents the requirements concerning the risk assessment with respect to several hazards at workplace. The document is available via https://ww1.issa.int/sites/default/files/documents/prevention/2chemical_hazards_080110_en-36373.pdf

2 Hazardous properties of chemical substances

Those chemicals which – due to their properties – emanate physical hazards, hazards to the human health and the environment, and which are classified according to the criteria of the Globally Harmonized System (GHS) of the UN, are also called "hazardous substances" or "hazardous mixtures". It is the objective of the GHS to globally standardize the criteria, as well as the corresponding labelling resulting from those criteria.

The CLP Regulation, the Regulation on Classification, Labelling, and Packaging of substances and mixtures, implements the GHS in Europe.

Hazard pictograms on the labels of the delivered packages, together with the corresponding hazard statements (H-phrases), warn of the individual hazards involved with the chemical substance in question. In certain cases, only the hazard statement is used. In other cases, such as with articles or products that can release hazardous substances, neither pictograms nor H-phrases are used, because they are not labelled.

The hazards arising from substances or mixtures are differentiated into acute and chronic hazards. With acute hazards, the health damaging effects caused by one or more single exposures appear immediately, or within a short, defined time frame. The absorption into the body that is connected with the exposure can be inhalative through breathing, dermal through the skin, or oral through ingestion.

The so-called chronic hazards are those hazards where health damaging effects caused by repeated exposure are delayed and appear only after longer time periods, as is the case with carcinogenic effects.

Acute and chronic health damaging effects can be reversible or irreversible. Reversible means that when exposure ends the symptoms disappear entirely – depending on the respective damaging effect – after appropriate treatment. This is not the case with irreversible health damaging effects, where symptoms and secondary damage cannot be reversed entirely, even after exposure ends and treatment is completed.

Specific substances such as asbestos are not considered in this brochure. Since 1st January 2005, the use of asbestos has been banned throughout the whole European Union and European legislation has set strict standards for the protection of workers in situations where they might be exposed.

Further information is to be found, for example, via https://osha.europa.eu/en/legislation/guidelines/a-practical-guide-on-best-practice-to-prevent-or-minimise-asbestos-risks.

2.1 Health hazards

2.1.1 Toxic effects

Toxic health effects may be caused by oral or dermal administration or inhalation of a relatively small amount of a chemical substance, which immediately or within a short time frame causes health damage or even death.

Depending on the severity of the effects, there is a distinction between fatal, toxic, and harmful.

The "Skull and Crossbones" hazard pictogram is used for fatal and toxic chemicals.

H300: Fatal if swallowed.

H301: Toxic if swallowed.

H310: Fatal in contact with skin.

H311: Toxic in contact with skin.

H330: Fatal if inhaled.

H331: Toxic if inhaled.

Combinations such as the following are possible too, e.g.

H300 + H310: Fatal if swallowed or in contact with skin.

For instance, potassium cyanide or hydrofluoric acid can be fatal when swallowed, inhaled or in contact with skin.

Inhalation of chlorine gas is also fatal. Phenol is toxic if swallowed, inhaled, or in contact with skin. Ammonia, formic acid, and chloroform are toxic if inhaled.

The "Exclamation Mark" hazard pictogram warns of harmful chemicals.

H302: Harmful if swallowed.

H312: Harmful in contact with skin.

H332: Harmful if inhaled.

For instance, formic acid or chloroform are harmful if swallowed. Xylene is harmful if inhaled or in contact with skin.

The examples illustrate how the severity of the effect can be different for each chemical substance depending on the various exposure routes.

2.1.2 Skin corrosion or eye damage

The danger of corrosion exists when contact with a chemical substance leads to irreversible and serious damage of skin or eye tissue. The hazard pictogram "Corrosion" warns of such serious chemical burns or such serious eye damage.

H314: Causes severe skin burns and eye damage.

H318: Causes serious eye damage.

Strong acids like sulphuric acid, or acetic acid, as well as strong bases like sodium hydroxide or potassium hydroxide cause serious skin corrosion and serious eye damage. However, other substances like diethanolamine, n-butanol, or n-propanol also cause serious eye damage.

In addition to their skin and eye damaging effects, chemicals can be corrosive to the respiratory tract as well, as is the case with ammonia gas. The special H phrase, which is used as a supplemental information on the label in Europe, is EUH071 "Corrosive to the respiratory tract".

2.1.3 Irritation of skin or eyes

Skin or eye irritation exists if contact with a chemical substance leads to reversible damage. This includes serious eye irritations. The "Exclamation Mark" hazard pictogram warns of these hazardous properties.

H315: Causes skin irritation.

H319: Causes serious eye irritation.

For example, diluted hydrochloric acid or acetic acid cause skin irritations and serious eye irritations. Dimethylformamide (DMF) causes serious eye irritations.

2.1.4 Respiratory or skin sensitisation or allergy

Sensitisation is the immune reaction of the body caused by initial contact with a sensitising substance. In case there is repeated contact even with very small amounts, there can be an individual excessive allergic reaction of the body.

Sensitizing chemicals follow an all-or-nothing reaction: If a worker has been sensitized to such a chemical in former days, an allergic reaction will occur when the worker is exposed to this substance again. The allergic reaction may take place even with tiny amounts of the substance. There are different types of allergic responses, for inhalable and for dermal effects, ranging from life-threatening anaphylactic shock to chronic reactions like asthma or eczema. Anyway, also chronic allergic reactions can be disabling, and the affected person has to follow strict protection measures or to leave the working place.

An allergy, asthma, or respiratory difficulties can be caused by inhalation of chemicals with this hazardous property. The "Health Hazard" hazard pictogram warns of this health hazard.

H334: May cause allergy or asthma symptoms or breathing difficulties if inhaled.

For instance, 4,4'methylenedi(isocyanate) (MDI), glutaraldehyde, and phthalic anhydride are respiratory sensitising substances.

The "Exclamation Mark" hazard pictogram is used for chemicals if they can cause allergic reactions through contact with the skin.

H317: May cause an allergic skin reaction.

4,4'methylenedi(isocyanate) (MDI), glutaraldehyde, and phthalic anhydride are also examples of skin sensitising substances; as are cooling lubricants, glyoxal, many rubber chemicals like thiram or latex, bisphenol A, some exotic woods, flour dust, or epoxy resins.

2.1.5 Specific organ toxicity after single exposure

If chemicals have or may have definite health damaging effects on a specific target organ after a single exposure, then they are said to have "Specific Target Organ Toxicity (STOT) – single exposure". The health damaging effects can be reversible or irreversible, and be immediate and/or delayed, but not lethal. Respiratory tract irritation and narcotic effects are transient specific target organ effects after single exposure.

These are effects that adversely alter human function for a short duration after exposure and from which humans may recover within a reasonable period without leaving significant alteration of structure or function.

2.1.5.1 Causing damage to organs (systemic effects)

Depending on the severity of the health effects caused by chemicals with these hazardous properties, there is a distinction between "causes damage to organs" and "may cause damage to organs". In both cases, the "Health Hazard" hazard pictogram is used.

H370: Causes damage to organs (or state all organs affected, if known) (state route of exposure if it is conclusively proven that no other routes of exposure cause the hazard).

H371: May cause damage to organs (or state all organs affected, if known) (state route of exposure if it is conclusively proven that no other routes of exposure cause the hazard).

Methanol is an example for H370, and the target organ is the optic nerve (as methanol causes damage to the eyes by blinding).

2.1.5.2 Respiratory tract irritation

The "Exclamation Mark" hazard pictogram also warns of chemicals that can cause irritations to the respiratory tract after a single exposure, with symptoms like coughing, pain, dyspnoea (shortness of breath) and general breathing difficulties.

H335: May cause respiratory irritation.

For example, hydrochloric acid, ammonia solution, n-butanol, and formaldehyde have irritating effects on the respiratory tract.

2.1.5.3 Narcotic effects

The "Exclamation Mark" hazard pictogram is used for chemicals that may have narcotic effects like drowsiness and fatigue on the target organ nervous system even after one exposure.

H336: May cause drowsiness or dizziness.

Examples are many organic solvents like n-butanol, isobutanol, n-propanol, toluene, n-hexane.

2.1.6 Specific organ toxicity after repeated exposure

If chemicals are in danger of having definite health damaging effects on a specific target organ after a longer exposure, or repeated exposure, then they are said to have "Specific Target Organ Toxicity" (STOT) - repeated exposure". The health damaging effects can be reversible or irreversible, and be immediate or delayed, but not lethal.

Depending on the severity of the health effects caused by chemicals with these hazardous properties, there is a distinction between "causes damage to organs" and "may cause damage to organs". In both cases, the "Health Hazard" hazard pictogram is used.

H372: Causes damage to organs (or state all organs affected, if known) through prolonged or repeated exposure (state route of exposure if it is conclusively proven that no other routes of exposure cause the hazard).

H373: May cause damage to organs (or state all organs affected, if known) through prolonged or repeated exposure (state route of exposure if it is conclusively proven that no other routes of exposure cause the hazard).

For example, repeated exposure to nickel causes damage to the lungs.

2.1.7 Aspiration

Aspiration means the entry of a liquid or solid substance or mixture directly through the oral or nasal cavity, or indirectly from vomiting, into the trachea and lower respiratory system. Aspiration toxicity includes severe acute effects such as chemical pneumonia, varying degrees of pulmonary injury or death following aspiration.

The "Health Hazard" hazard pictogram is used for chemicals with these hazardous properties.

H304: May be fatal if swallowed and enters airways.

Examples are organic solvents such as xylene, cyclohexane, n-pentane, or n-heptane. In addition, the hazard also applies to specific hydrocarbon mixtures used as solvents or thinners in paint, lacquer, varnish, and adhesives, as well as components of industrial cleaning agents.

2.1.8 Carcinogenicity

Carcinogenic substances may lead to cancer typically many years after exposure. Therefore, the effectiveness of measures is not immediately visible. Cancer may cause great impairments or even death.

Based on the strength of evidence for carcinogenic effects, chemical substances are differentiated into ones that "may cause cancer", and ones that are "suspected of causing cancer". In both cases, the "Health Hazard" hazard pictogram is used. The legal requirements for the first group (H350 and H350i) are more extensive than for chemicals suspected of being carcinogenic (H351).

Examples of chemicals that can cause cancer are acrylonitrile, benzene, nickel oxides, chromates, nitrosamines, ethylene oxide, vinyl chloride, as well as asbestos and hard wood dusts. Examples of substances with suspected carcinogenic effects are tetrahydrofuran and dichloromethane.

H350: May cause cancer (state route of exposure if it is conclusively proven that no other routes of exposure cause the hazard).

H350i: May cause cancer by inhalation.

H351: Suspected of causing cancer (state route of exposure if it is conclusively proven that no other routes of exposure cause the hazard).

2.1.9 Germ cell mutagenicity (genetic alteration)

A permanent change in genetic material (DNA) is called a mutation. Chemicals with germ cell mutagenicity may cause mutations in the germ cells (sperm or ovum) of humans, which are passed on to offspring and become hereditary. These kinds of damage are also called genetic defects.

Mutations may represent the first step in carcinogenesis. However, not every mutagenic substance is necessarily a carcinogen because not every mutation leads to cancer: it needs more than just a mutation in the DNA, several additional steps are necessary to get cancer ("multistage model of carcinogenesis"). Conversely, not every carcinogen is a mutagen because chemicals may cause cancer by other mechanisms than by direct damage to the DNA ("non-genotoxic carcinogens").

Similarly to the distinction made between carcinogenic substances, there is a differentiation based on the strength of evidence between chemicals that can cause genetic defects and chemicals that are suspected of causing genetic defects. The "Health Hazard" hazard pictogram warns of both.

H340: May cause genetic defects (state route of exposure if it is conclusively proven that no other routes of exposure cause the hazard).

H341: Suspected of causing genetic defects (state route of exposure if it is conclusively proven that no other routes of exposure cause the hazard).

For instance, acrylamide, benzene, benzo(a)pyrene, or ethylene oxide can cause genetic defects. Formaldehyde, glyoxal, or 4-chloro-o-toluidine (4-Chloro-2-methylaniline) are suspected of causing genetic defects.

2.1.10 Reproductive toxicity

Substances are called "reproductive toxicants" when they adversely affect either fertility or sexual function in men or women, or when they produce damaging effects on the development of descendants. Disorders of fertility are, for example, disruptions in the reproductive organs, gametes, regularity of reproductive cycle, and gravidity. Disorders of development of the developing offspring can be caused either by exposure of the parents before conception or by exposure of the descendant before birth.

The differentiation between the two effects is reflected by the labelling:

- Damaging effects on sexual function and fertility in adult men and women (impairment of fertility) – letter "F"/"f" after the H-phrase.
- Damaging effects on the development of unborn offspring (developmental toxicity) – letter "D"/"d" after the H-phrase.

Reproductive toxicity also comprises damaging effects on lactation or damage to the offspring via lactation. A chemical substance can emit either only one, or else a combination of all these forms of hazard for reproduction.

Here too there is a differentiation based on the strength of evidence between chemicals that may damage fertility or the unborn child and chemicals that are suspected of doing so. In both cases, the "Health Hazard" hazard pictogram is used.

H360: May damage fertility or the unborn child (state specific effect if known) (state route of exposure if it is conclusively proven that no other routes of exposure cause the hazard).

H360F: May damage fertility.

H360D: May damage the unborn child.

H360FD: May damage fertility. May damage the unborn child.

H360Fd: May damage fertility. Suspected of damaging the unborn child.

H360Df: May damage the unborn child. Suspected of damaging fertility.

H361: Suspected of damaging fertility or the unborn child (state specific effect if known) (state route of exposure if it is conclusively proven that no other routes of exposure cause the hazard).

H361f: Suspected of damaging fertility.

H361d: Suspected of damaging the unborn child.

H361fd: Suspected of damaging fertility. Suspected of damaging the unborn child.

For example, carbon monoxide, dimethyl formamide (DMF), lead alkyls, and lead acetate may damage the unborn offspring. Furthermore, lead alkyls and lead acetate are presumed to damage fertility, i.e. they are suspected of this additional reproductive toxic effect.

Chloroform is an example of a substance suspected of damaging the unborn offspring. Ethyl glycol and boron oxides such as borax may damage fertility as well as the unborn offspring.

2.1.11 Effects on or via lactation

There is no hazard pictogram used for damaging effects on lactation or damage to offspring via lactation, but only the hazard statement H362. Lead powder is an example of such a chemical.

H362: May cause harm to breast-fed children.

2.1.12 Suffocation and cryogenic burns or injury

The percentage of oxygen in the air is 20.9%. Oxygen levels below 19% present a health risk, since lack of oxygen can lead to failure of vital body functions. There is a danger of suffocation when the oxygen concentration in the surrounding air is reduced through leaking gases – independent of whether the gases are toxic or not. Handling dry ice may cause a similar effect because of the emitted carbon dioxide. Especially within cramped, poorly ventilated spaces (e.g. basements, containers, silos, as well as lifts (elevator cars) or the insides of automobiles), escaping gases can lead to death through suffocation (through leakage in piping or gas cylinder systems, e.g. of nitrogen, helium, argon, or carbon dioxide).

If they are used as compressed gases, liquefied gases, or gases dissolved under pressure, they are labelled with the "Gas Cylinder" hazard pictogram (see 2.2.1). When they are refrigerated, they may cause cryogenic burns or injury as well.

H281: Contains refrigerated gas; may cause cryogenic burns or injury.

2.2 Physical Hazards

2.2.1 Gases under Pressure

The "Gas Cylinder" hazard pictogram warns of compressed gases, liquefied gases, or gases dissolved under pressure. When bottles are heated, they may explode.

H280: Contains gas under pressure; may explode if heated.

H229: Pressurised container: May burst if heated.

2.2.2 Explosive Substances

There is a danger of explosion when a substance or a mixture of substances expands abruptly through a reaction or decomposition in a very short time span (split seconds), thus causing a huge increase in pressure.

H200: Unstable explosives.

H201: Explosive; mass explosion hazard.

H202: Explosive, severe projection hazard.

H203: Explosive; fire, blast or projection hazard.

H204: Fire or projection hazard.

H240: Heating may cause an explosion.

H241: Heating may cause a fire or explosion.

H205: May mass explode in fire.

H206: Fire, blast or projection hazard; increased risk of explosion if desensitising agent is reduced.

H207: Fire or projection hazard; increased risk of explosion if desensitising agent is reduced.

H208: Fire hazard; increased risk of explosion if desensitising agent is reduced.

The "Exploding Bomb" hazard pictogram is used firstly for explosive substances produced explicitly for the purpose of procuring an explosion or a pyrotechnical effect. Gases can develop at such speed, temperature, and pressure as to cause damage to the surroundings. Examples are civil and military explosives (e.g. trinitrotoluene (TNT), nitroglycerin), as well as fireworks. Pressure increases of several thousand bars can occur.

The hazard pictogram is also used for self-reactive substances (for example ones with high exothermic decomposition), as well as especially hazardous organic peroxides (e.g. dibenzene peroxide). These substances are brought to explosion by flame ignition or are reactive to impact, shock, or friction. There is also the hazard of shrapnel or splinters, fragments, and debris.

For desensitised explosives the "Flame" hazard pictogram is used.

2.2.3 Fire and Explosion

Fires and explosions are caused by reaction of flammable substances with oxygen in the presence of an ignition source. The "Flame" hazard pictogram is used for various substances that can cause or contribute to fire in different ways.

H220: Extremely flammable gas.

H222: Extremely flammable aerosol.

H223: Flammable aerosol.

H224: Extremely flammable liquid and vapour.

H225: Highly flammable liquid and vapour.

H226: Flammable liquid and vapour.

H221: Flammable gas.

H228: Flammable solid.

H230: May react explosively even in the absence of air.

H231: May react explosively even in the absence of air at elevated pressure and/or temperature.

H232: May ignite spontaneously if exposed to air.

H242: Heating may cause a fire.

H250: Catches fire spontaneously if exposed to air.

H251: Self-heating: may catch fire.

H252: Self-heating in large quantities; may catch fire.

H260: In contact with water releases flammable gases which may ignite spontaneously.

H261: In contact with water releases flammable gases.

Examples for flammable gases are methane or hydrogen. Vapours of flammable liquids may be emitted by, for instance gasoline or solvents like acetone. The "Flame" pictogram points to this hazard.

Some solids are flammable as well and must be labelled with the "Flame" hazard pictogram, for example sulphur. The flammability of metallic powders depends on how finely powdered they are, for example magnesium.

White phosphorus is known to ignite when in contact with air. This substance, together with other comparable solids (e.g. aluminium alkyls) and liquids (e.g. butyl lithium) are called "pyrophoric". Here too, the flame is used as a pictogram – bringing these substances into contact with flammable liquids should be strictly avoided, even if both substance classes bear the same hazard pictogram.

Finally, some substances (e.g. sodium) release flammable gases that may ignite spontaneously on contact with water. Such substances are labelled with the "Flame" hazard pictogram too.

2.2.4 Oxidizing Substances

Since fires and explosions are caused by flammable substances reacting with oxygen, substances emitting oxygen cause or contribute to fire.

H270: May cause or intensify fire; oxidizer.

H271: May cause fire or explosion; strong oxidizer.

H272: May intensify fire; oxidizer.

The "Flame over Circle" hazard pictogram warns of substances that readily emit oxygen (or other oxidizing substances like chlorine), thus causing or contributing to fire. Among these substances are potassium nitrate (which acts as an oxidizing agent in black powder), highly concentrated nitric acid, and perchloric acid, as well as inorganic peroxides like hydrogen peroxide and sodium peroxide.

Of course, oxygen as a gas is also labelled as oxidizing, as are several other gases such as chlorine or nitrogen oxide, which can cause or accelerate fire as well.

2.3 Environmental hazards

2.3.1 Water

H400: Very toxic to aquatic life.

H410: Very toxic to aquatic life with long lasting effects.

H411: Toxic to aquatic life with long lasting effects.

H412: Harmful to aquatic life with long lasting effects.

H413: May cause long lasting harmful effects to aquatic life.

The "Environmental Hazard" hazard pictogram warns of substances that can be hazardous to fish, crustaceans, algae, and aquatic plants.

2.3.2 Air

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

In addition to signalling certain health-damaging effects, the "Exclamation Mark" hazard pictogram also warns of substances that present a danger to the stratospheric ozone layer and are thus harmful to public health and to the environment. Halogenated hydrocarbons are examples of such substances.

3 Obtaining information about the properties and hazards

3.1 The Label

The label provides information about the hazards of a substance or a mixture classified as hazardous.

The label put on the packaging of such a substance or mixture shall bear the following elements:

Nr	Label of a mixture (example)
1	Hydrocarbon mixture hydrocarbons, C9-C11, isoalkanes, cyclics
2	• Highly flammable liquid and vapour. (H225) • May be fatal if swallowed and enters airways. (H304) • May cause drowsiness or dizziness. (H336) • Toxic to aquatic life with long lasting effects. (H411)
3	• Keep away from heat, hot surfaces, sparks, open flames and other ignition sources. No smoking. (P210) • Avoid breathing fume/gas/mist/vapours/spray. (P261) • Avoid release to the environment. (P273) • IF SWALLOWED: Immediately call a POISON CENTER/doctor. (P301 + P310) • Do NOT induce vomiting. (P331)
4	Repeated exposure may cause skin dryness or cracking. (EUH066)
5	DANGER
6	
7	Manufactured by John Doe's Company Mainstreet, 23 12345 Anytown Tel. 0123/45678-00
8	1 L

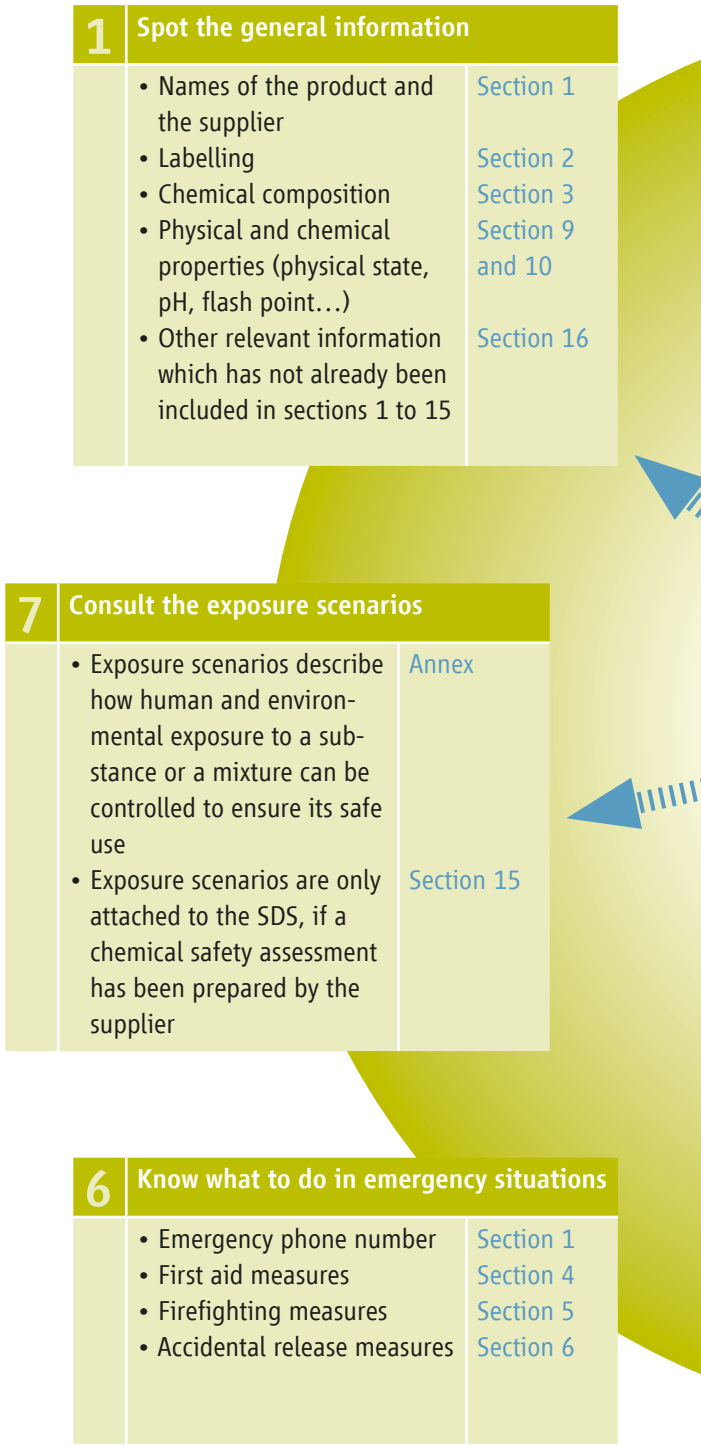
Trade name: name of the mixture	The name of the substance and an identification number or the trade name or the designation of the mixture; for a mixture, some additional information is necessary concerning the identities of all substances in the mixture that contribute to the classification of the mixture as regards acute toxicity, skin corrosion or serious eye damage, germ cell mutagenicity, carcinogenicity, reproductive toxicity, respiratory or skin sensitisation, specific target organ toxicity (STOT) or aspiration hazard.
Hazard statements	The hazard statements: A hazard statement describes the nature and severity of the hazards of a substance or mixture. They can be accompanied by their codes (here H225, H304, H336 and H411).
Precautionary statements	The appropriate precautionary statements: A precautionary statement gives advice on measures to prevent or minimise damaging effects to human health or the environment arising from the hazards of a substance or mixture. They can be accompanied by their codes (here P210, P261, P273, P301+P310, P331).
Supplemental information	A section for supplemental information e.g. EUH phrases (here EUH066).
Signal word	The signal words: A signal word indicates the relative level of severity of a particular hazard. The label must include the relevant signal word in accordance with the classification of the hazardous substance or mixture; more severe hazards require the signal word "Danger" while less severe hazards require the signal word "Warning".
Hazard pictograms	The hazard pictograms: a hazard pictogram is a pictorial presentation to communicate information on the hazard concerned.
Supplier identity	The name, address and telephone number of the supplier.
Nominal quantity	The nominal quantity of the substance or mixture in the package made available to the general public, unless this quantity is specified elsewhere on the package.

3.2 The Safety Data Sheet / Material Safety Data Sheet

The Safety Data Sheet (SDS) – in some countries named Material Safety Data Sheet (MSDS) – contains 16 sections that are explained below. It provides more details than the label and is therefore an important source for identifying whether any hazardous substance or mixture is handled at the workplace. It informs employers and employees of the hazards of a substance or mixture and provides information on the safe storage, handling and disposal of the substance or mixture. In addition, the SDS allows employers to assess any risk to health and safety arising from use.

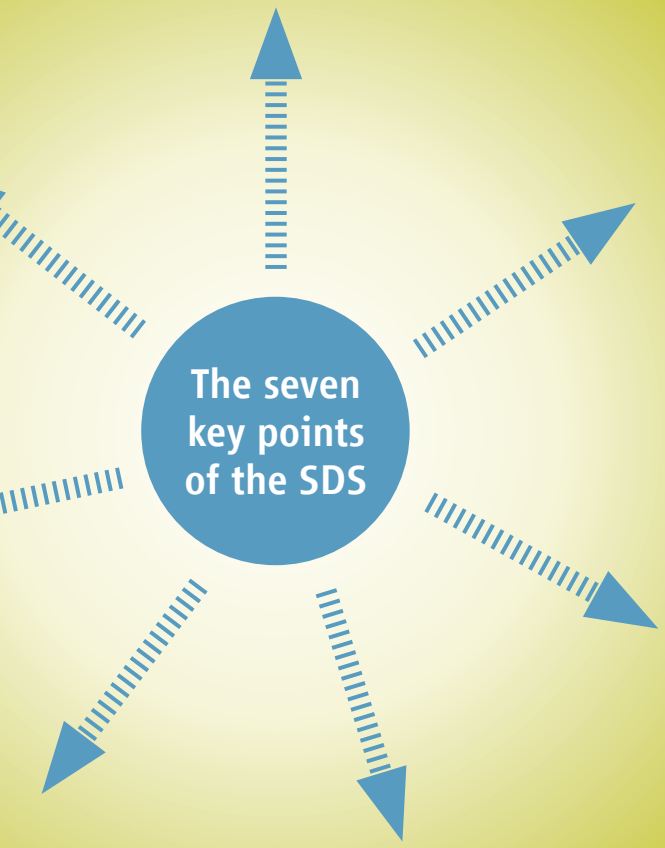
Additional information may be provided from exposure scenarios attached to the SDS. The information in the SDS and exposure scenarios helps to protect the workers and the environment.

The SDS and any updates must be provided free of charge. The language used in the SDS shall be simple and clear. The SDS should be written in the official national language(s) of the country where the chemical is put on the market.



2 Know the hazards related to the product

• Flammability, explosive properties, stability, reactivity	Sections 2, 9 and 10
• Health	Sections 2 and 11
• Environment	Sections 2 and 12



3 Use the product correctly

• Relevant identified uses and uses advised against	Section 1
• Handling and storage	Section 7 and 15
• Collective equipment (confinement, ventilation) and personal protection (e.g. hand protection, respiratory protection, eye and face protection, shoes, work clothing)	Section 8
• Occupational Exposure Limit (OEL) values	Section 8
• Authorisations and restrictions	Section 15
• National regulatory measures	Section 15

4 Dispose of the product

• Waste management	Section 13
• Management of contaminated packaging	Section 13

5 Find information for transport

• Recommendations	Section 14
• Classification concerning international agreements on transport of dangerous goods: ADR (European Agreement concerning the International Carriage of Dangerous Goods by Road), RID (Regulations concerning the International Carriage of Dangerous Goods by Rail) and ADN (European Agreement concerning the International Carriage of Dangerous Goods by Inland Waterways), IMDG (International Maritime Dangerous Goods), ICAO-TI (International Civil Aviation Organisation-Technical Instructions), IATA-DG (International Air Transport Association-Dangerous Goods Regulations)	Section 14

3.3 Other information sources

Other sources of information on the chemical substances are available, e.g.:

The C&L Inventory

This database of the ECHA (European Chemicals Agency) contains classification and labelling information on notified and registered substances received from manufacturers and importers. It also includes the list of harmonised classifications. The database is refreshed regularly with new and updated notifications.

http://echa.europa.eu/information-on-chemicals/cl-inventory-database

GESTIS

GESTIS is the information system on hazardous substances of the German Social Accident Insurance. This database contains information about approx. 8700 substances to the following items: identification, toxicology/ecotoxicology, physical and chemical properties, occupational health and first aid, safe handling, regulations.

http://www.dguv.de/ifa/gestis/index.jsp

eChemPortal

It provides free public access to information on properties of chemicals (including physical and chemical properties, environmental fate and behaviour, ecotoxicity and toxicity). eChemPortal direct links to collections of information prepared for government chemical programmes at national, regional, and international levels. The Organisation for Economic Co-operation and Development (OECD) is responsible for the development of the Portal itself. The European Chemicals Agency (ECHA) is responsible for the hosting of eChemPortal.

http://www.echemportal.org/echemportal/

IPCS INCHEM

The International Programme on Chemical Safety (IPCS) INCHEM website gives information on chemicals commonly used throughout the world, which may also occur as contaminants in the environment and food. IPCS INCHEM is produced through cooperation between the International Programme on Chemical Safety (IPCS) and the Canadian Centre for Occupational Health and Safety (CCOHS); IPCS INCHEM directly responds to one of the Intergovernmental Forum on Chemical Safety (IFCS) priority actions to consolidate current, internationally peer-reviewed chemical safety-related publications and database records from international bodies, for public access.

www.inchem.org/

3.4 Non-GHS-labelled substances

Not all hazardous substances are labelled with GHS pictograms. A few products without labelling, like flour dust or used motor oil, can have health damaging effects or physical effects. Furthermore, the suffocation effects of gases as described in chapter 2.1.12 are often not labelled.

CNTs (carbon nanotubes) are cylindrical carbon molecules, which are already being used in many different fields including electronics, optics, materials technology and many more. The effects on human health are under investigation. However, since some CNTs form fibres that can sometimes be carcinogenic, special attention is paid to CNTs. In some countries, workers exposed to CNTs have to follow strict protection rules and are included in special preventive occupational medical surveillance programmes. In addition, articles and waste are typically not labelled but must be taken into consideration due to possible hazards.

3.5 Hazardous substances which can be released during processes

There are substances, such as welding fumes, diesel engine emissions, fumes emitted during smelting, dust (e.g. wood dust, crystalline silica) and fumes from machining or grinding of plastics and resins, which can be released during processing. Even though they are hazardous, these substances emitted during processes are not classified as such.

3.6 The interface with the legislation on Transport of Dangerous Goods

Hazardous substances and mixtures can become dangerous goods on leaving the production company by transport on public routes. Conversely, dangerous goods turn back into hazardous substances as soon the transport arrives at an enterprise and the transportation processes are completed. For further information, the ISSA Chemistry section provides the video "Dangerous goods and hazardous substances: transport safely – work safely" (http://downloadcenter.bgrci.de/shop/ivss).

4 From hazards to measures

4.1 Introduction

Preventing chemical risks requires risk assessment, which must be renewed regularly and, in particular, for every major change in the work processes: amount of chemicals used, type of process etc. The assessment process should involve, as far as possible, all relevant players. It takes place in several steps:

4.2 Collecting information and identifying hazards

The first step is to identify and list the names of the chemicals encountered in the company. This inventory, as exhaustive as possible, should take into account:

- Raw materials;
- By-products and intermediates (including those emitted by processes or operations: smoke emissions, degradation products, mists, dust, etc.);
- Finished products;
- Cleaning or maintenance products;
- Waste.

Several sources of information can help with this identification as described in detail in chapter 3: list of purchased chemicals and materials, inventories, the SDSs, labels, operation procedures etc. Consultation of employees and observation of workstations and storage makes it possible to add any chemicals and processes that do not appear on the previous documents: samples submitted by sales representatives, intermediate waste, etc. During this inventory, available information like quantities used, hazards, type of workplace is collected.

Generally, due to the high number of chemicals present in an establishment, software is very useful for collecting and storing this information, which must be regularly updated. This step can be time-consuming if information is not present or is not structured on the premises.

If some chemicals are not in use any more, dispose of them appropriately.

4.3 Assessing risks arising from hazards

The employer shall assess any risk to the safety and health of workers arising from the presence of hazardous substances or mixtures, taking into consideration:

- health hazards:
  - the level, type and duration of exposure;
  - the circumstances of work involving such agents, including quantities;
  - any occupational exposure limit values in order to evaluate exposure by inhalation;
  - handling substances with danger of percutaneous absorption: for such substances, which can penetrate the skin easily, complying with the occupational exposure limit value alone does not protect the health of employees sufficiently. Skin contact must be eliminated through process control measures, organisational and personal protective measures. A workplace evaluation in these cases should be supplemented by biological monitoring with the help of the respective limit values, the biological limit values.

- physicochemical hazards:
  - the concentrations of inflammable substances or hazardous quantities of chemically unstable substances;
  - ignition sources which could give rise to fires and explosions;
  - adverse conditions which could cause chemically unstable substances or mixtures of substances to give rise to harmful physical effects.

ISSA Chemistry brochures concerning explosion hazards

To get an idea about the hazards from explosions and how they can be countered by suitable measures the fundamental information can be found in the ISSA-brochures on "Gas Explosions" (ISSA-34), "Dust Explosions" (ISSA-32e), and lessons to learn from "Dust Explosion Incidents" (ISSA-43e). Furthermore, there is an ISSA brochure available giving general information on avoidance of ignition sources (ISSA-40) and another dealing explicitly with static electricity (ISSA-35e). For dust explosion protection for machines and equipment, a collection of examples is given in two brochures (ISSA-38e and ISSA-39). For availability see https://medienshop.bgrci.de/shop/ivss.

In the risk assessment, the hazards associated with the activities shall be assessed independently of one another and brought together. This step involves jointly analysing the hazards of the chemical agents, identified in the SDS or on the label, and the conditions at the workplace. If the number of chemicals used in the company is high, it is practical to set priorities by starting with the most hazardous and most used products.

The exposure in respect of health hazards could be estimated by using

- physical properties of the chemical (e.g. volatility, boiling point, dustiness);
- the type of process and the risk management measures such as ventilation;
- the routes of exposure (inhalation, cutaneous), frequency and duration of exposure etc.

The REACH exposure scenarios reported in the SDS may support this estimate. Tools have also been developed for this purpose, e.g. COSSH essentials (HSE, UK), eval.at (AUVA, Austria), GESTIS-Stoffenmanager (IFA, Germany), SEIRICH (INRS, France), Stoffenmanager (Cosanta, The Netherlands).

Another way of assessing the health risks is to perform exposure measurements and to compare the results with the occupational exposure limit (OEL) values mentioned in section 8 of the SDS, which can also be found in databases such as GESTIS International Limit Values (http://limitvalue.ifa.dguv.de/).

Measures must be taken, when exposure levels are higher than the OELs. So, the risks should be minimised. When no OEL exists, the exposure should be minimised to as low as possible.

Occupational Exposure Limit (OEL) values

OELs are defined as a limit of concentration of a chemical agent in the air at the workplace in order to protect workers from health damaging effects. There are health-based OELs, which achieve this aim, but for certain substances (especially for genotoxic carcinogenic substances) this cannot be guaranteed in all cases. For many carcinogenic substances it is usually impossible to define a concentration at which any health effects can definitely be ruled out. Therefore, exposure has to be minimized to as low as reasonably achievable (ALARA principle).

Some countries have established a risk-based concept, which limits the risks of getting cancer at the workplace to a very low level. In Germany, France and the Netherlands several additional risks are defined. For example, in Germany there are two different risk levels: acceptable and tolerable risk, which defines the probability of health damage occurring as a result of exposure to carcinogenic substances. It is important to know that these risks exceed the natural background rate. Substance-specific acceptable concentrations and tolerable concentrations are derived.

Other countries still follow a technology-based concept. For the carcinogenic substances with a threshold value, a health-based occupational exposure limit (OEL) can be derived. Exposure to these non-genotoxic carcinogens below the OEL is considered to have no risk of cancer. Carcinogens with thresholds have a special notification. Well-known examples of such substances are formaldehyde, wood dust, and sulphuric acid aerosols.

Ready to use hazardous substances?

4.4 Planning actions to eliminate or reduce risk

In the field of chemical risk prevention, several types of actions are possible to achieve the best possible control of chemical risks. The action plan consists of

	Measure		Explanation
S	Substitution of products or design of appropriate work processes and engineering controls and use of adequate equipment and materials, so as to avoid or minimise the release of hazardous chemical agents that may present risks to workers' safety and health at the workplace.	**S**ubstitution	The safest way to handle a harmful chemical is to avoid that chemical. This means the first step must be a check to determine whether substitution is possible: e.g. a corrosive dishwashing agent will be replaced by an irritant or in the most favourable way by a non-classified dishwashing agent.
T	Technical measures (collective protection such as spot extraction of emissions, etc.).	**T**echnical measures	If substitution of the chemical or the process is not possible, exposure to chemicals must be reduced by technical measures, e.g. encapsulating the process or local exhaust ventilation (LEV).
O	Organisational measures (emergency procedures, hygiene rules, etc.).	**O**rganisational measures	Exposure will be reduced by, for example, shortening the working time, or, reducing the number of persons in the working area of the harmful chemical.
P	Application of personal protection measures including personal protective equipment where exposure cannot be prevented by other means.	**P**ersonal protective equipment	Where exposure cannot be prevented by other means, the last and least possibility is using personal protective equipment (PPE). PPE is very often difficult and exhausting to work with and improper use leads to unsafe use.

For each activity involving risks, the measures to be implemented are prioritised by the employer according to:

- The level of the risks;
- The effectiveness and sustainability of the measures identified;
- The feasible speed of implementation.

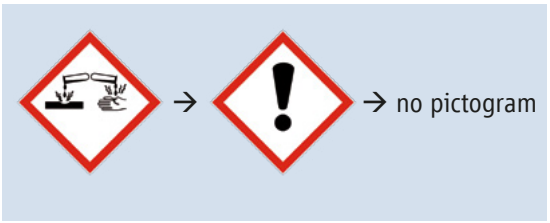
When a reduction measure requires a certain timeframe for implementation, interim measures should be adopted in the meantime: for example, until a closed-work system is operational, limitations on access to hazardous work areas should be strengthened.

Each action to reduce workplace hazards must be evaluated for the effectiveness of the measures implemented, for example, by using exposure or airflow measurements.

STOP

4.4.1 Substitution of hazardous chemicals

Substituting a hazardous chemical means finding a less hazardous chemical or an alternative process that can be used for the same purpose as the previous one. It is the first action that should be studied before modifications of the process and implementation of risk management measures.



For example, for solvent-based surface treatment agents for parquet and other wood floorings there are established substitute substances and substitute working methods described in the TRGS 617. The German Technical Rules for Hazardous Substances (TRGS) reflect the state of the art, the state of occupational health and occupational hygiene as well as other sound work-related scientific knowledge relating to activities involving hazardous substances including their classification and labelling.

The concept seems very simple but can be very challenging, because the selected chemical or process must not only be less hazardous (reducing health and physical risks etc.), but also be capable of performing the usage functions, for example: degreasing efficiency for a solvent, equivalent bactericide activity for a biocide etc. Particular attention must be paid to ensure that the selected alternative will not produce new risks whatever their nature: health, physical or environmental.

For example, substitution of a paint stripper with lower efficiency could lead workers to scrape paint residues harder and could give rise to musculoskeletal disorders over time. Another example can be illustrated by replacement of halogenated hydrocarbons with butane as a propellant gas in spray cans in order to prevent damage to the ozone layer. After such substitution, several accidents have been reported of people being seriously injured by inflammation of butane after using such spray cans.

During a substitution process, many other factors must be also considered such as: regulations, availability of the chemical product on the market, costs including the price of the selected chemical product and costs due to modifications of the process. Before a definitive substitution, the solution must be tested to check its efficiency and the associated risks.

Sources of information concerning substitution are available, e.g.:

The European Chemicals Agency ECHA provides references concerning how to substitute and shows real-life cases: https://echa.europa.eu/en/substitution-to-safer-chemicals

SUBSPORT is a European project offering a free-of-charge, multilingual platform for information exchange on alternative substances and technologies, as well as tools and guidance for substance evaluation and substitution management: www.subsport.eu/

The French Agency for Food, Environmental and Occupational Health & Safety ANSES has developed a tool to support, in particular, the substitution of CMR substances: www.substitution-cmr.fr/

The French National Research and Safety Institute for the Prevention of Occupational Accidents and Diseases INRS has published a Présentation des fiches d'aide à la substitution des cancérogènes (FAS): www.inrs.fr/media.html?refINRS=FAS%200

In Germany, the Federal Institute for Occupational Safety and Health BAuA has developed an easy-to-use workplace control scheme for hazardous substances (EMKG), which provides advice on controlling the use of chemicals: https://www.baua.de/EN/Topics/Work-design/Hazardous-substances/EMKG/Easy-to-use-workplace-control-scheme-EMKG_node.html

As an aid to the assessment of possible substitute substances, the Institute for Occupational Safety and Health of the German Social Accident Insurance (IFA) has developed the Column Model. On the basis of just a small amount of information on the products in question, substitute substances can be assessed with the aid of a table: https://www.dguv.de/ifa/praxishilfen/hazardous-substances/ghs-spalten-modell-zur-substitutionspruefung/index.jsp

The Organisation for Economic Co-operation and Development OECD offers a Tool Selector, which provides information on online resources and software that can be used in conducting chemical substitutions or alternatives assessments: www.oecds-aatoolbox.org/Home/Tools

The Occupational Safety and Health Administration OSHA of the United States Department of Labor offers a toolkit for employers and workers for transitioning to safer chemicals: www.osha.gov/dsg/safer_chemicals/index.html

Finally, there are some databases on chemicals that give hints about substitution. The International Chemical Safety Cards database provides online access to the collection of ICSCs as soon as they have been validated for publication by the International Labour Organization ILO: www.ilo.org/dyn/icsc/showcard.listCards2

STOP

4.4.2 Technical measures

If substitution with a less severe chemical cannot be performed, technical measures have to be implemented. The primary objective is to design and construct plants and processes in a manner that avoids setting free hazardous gases, vapours, suspended particles, solids and liquids. This can be achieved, for example, through closed systems. Closed systems are generally the best solution, but are very often difficult or impossible to achieve. For example, manual cleaning or various maintenance procedures can never be implemented within a closed system. In such cases, the next step is to install local exhaust ventilation (LEV). But it has to be considered that installing any kind of LEV or general ventilation is a highly sophisticated job that has to be done by experts, since the gases, vapours or dusts have to be disposed of without any danger for people and the environment.

Good general ventilation is also capable of reducing the concentration of hazardous chemicals in the air at the workplace, but only to some extent. Natural ventilation (opened doors and windows) will be sufficient in a few cases only and is dependent on various factors: e.g. during wintertime, doors and windows will be closed. All ventilation devices need to be checked and maintained regularly.

STOP

4.4.3 Organisational measures

The organisation of the working day can also help reduce the exposure at any given workplace. Exposure shall be minimised by:

- Restricting certain areas: e.g. welding areas should be located away from the entrance and as far away as possible from other work stations. Areas where workers are exposed to carcinogenic or germ cell mutagenic substances have to be demarcated by using adequate warning and safety signs including "no smoking" signs.
- Reducing the number of exposed persons: during certain activities only the chemical-applying workers shall be in the area of the use of the chemical: e.g. certain areas within a pharmacy that are used for formulating are separated from the salesroom.
- Reducing the time of exposure: If a drying period is required for a paint, it is best to use the paint just before the end of the working shift or to have separated drying areas. Thus, exposure caused by further evaporation during the period of drying will not affect workers.
- Reducing the quantity of chemical agents present at the workplace to the minimum required for the type of work concerned.
- Safe storage conditions for chemicals reduce the risk of accidents. More information can be found in the ISSA brochure "Storage of chemicals: Guidelines for good practice" (ISSA 11e, https://medienshop.bgrci.de/shop/ivss).
- Toxic substances must be stored in locked places.
- Repackaging of chemicals requires the use of suitable containers, taking care to transfer all the necessary information from the original labelling. It is recommended to ask the supplier to take back empty containers, obsolete products, and products or substances whose use is now prohibited.

Occupational hygiene: Basic Rules

Preventing exposure to chemical agents involves complying with hygiene measures, which supplement the technical and organisational prevention measures.

In addition to the specific instructions for each company, the following general rules may be listed:

- Do not drink, eat or smoke at the workplace and do not store food, beverages, drugs or tobacco on premises where a chemical hazard has been identified.
- Store work clothes separately from city clothes.
- Do not wear soiled work clothes in places such as offices, seminar rooms, lounge areas, corporate restaurants or cafeterias.
- Do not leave the establishment with work clothes or personal protective equipment.
- Change work clothes frequently and whenever they have been contaminated with hazardous chemical agents (note that leather or other porous materials are not cleanable: once contaminated, they must be disposed of as waste chemicals).
- Wash hands before each break and at the end of the shift.
- If necessary, take a shower at the end of the shift.
- Avoid deposits of dusts.

Focus on washing hands

The hands are firstly a gateway via which many hazardous chemical agents can enter the body, and secondly a vector of contamination. Even after wearing protective gloves, it is necessary to wash hands.

Hands should be washed with mild soap and warm water and then dried. Cleaning the skin using solvents (e.g. alcohol, acetone, white spirit) or petrol (gasoline) is absolutely to be avoided, because it promotes entry of hazardous chemical agents into the body through the skin and such solvents can themselves be hazardous to health.

Cleaning the premises

In order to avoid contamination by contact, resuspension in air or transfer to other premises of chemical pollutants (in the form of dust, fibres, aerosols, etc.), it is important to clean premises and workstations regularly.

Cleaning by dry sweeping or blowing must be prohibited because it causes suspension of the particles. The use of industrial vacuum cleaners equipped with filters adapted to the types of pollutant present (high-efficiency particle filters) and floor cleaning machines or “wet” cleaning should be preferred.

STOP

4.4.4 Personal protective equipment

As a last resort, the use of personal protective equipment (PPE) can help reduce the health-damaging effects of chemicals at workplaces, but it is not allowed to use PPE instead of the feasible measures listed above. Workers shall use the PPE provided as long as a risk exists. PPE has to protect workers, but discomfort has to be kept to a minimum: e.g. the use of respiratory protective equipment (RPE) is tiring or at least inconvenient. The use of burdensome PPE shall not be an enduring measure. It shall be restricted for each worker to the absolutely essential minimum.

For using PPE, there are several legal requirements for time restrictions and medical examination of the worker. All PPE must be maintained in an appropriate way. This means the employer has to ensure that the PPE:

- is stored in an appropriate fashion at a location intended for the purpose;
- is checked prior to use and cleaned after use, and damaged personal protective equipment is repaired or replaced before any further use;
- is checked regularly according to the function and effectiveness.

A wide range of PPE is available. In many cases, the choice of the proper PPE is rather difficult, especially for gloves and RPE. Such a choice has to be made by experts in occupational health and safety.

Gloves are part of skin protection plans in many companies. Such skin protection plans explain how and when to clean the hands correctly, how to protect them and how to take care of them after exposure to hazardous substances. Dependent on their material, protective gloves only offer protection against certain hazardous substances. Therefore, it is important to choose the appropriate chemical protective glove. The following references should be found in Section 8 of the Safety Data Sheet "Exposure control/Personal protection":

- the type of material;
- the breakthrough time of the glove material, with regard to the amount and duration of dermal exposure.

Information on suitable chemical protective gloves can be obtained from the manufacturers of the gloves or chemicals.

A lot of PPE needs special training. For example, even the use of gloves needs knowledge and training for the correct (non-contaminating) way to put them on and to take them off, efficient visual testing, period of use, etc.

4.4.5 Special measures for sensitive groups

Sensitive groups comprise pregnant or breast-feeding women, persons younger than 18 years or workers with diseases and disabilities. Such people may be especially sensitive to certain chemicals and they therefore need special protective measures.

In many countries there exist special regulations for sensitive groups. For example, there often exist precise instructions for pregnant women concerning health at work. In many countries, companies are obliged to assess the risks and to determine special protective measures for pregnant women. This includes informing young women, making special protective measures available, banning pregnant women from working at defined workplaces, suggestion of alternative workplaces etc. For some substances there exist special restrictions, such as reprotoxic substances.

It is also the duty of pregnant women themselves to inform the employer and to contact the occupational physician, in order to manage the necessary specific protective measures.

4.5 Documenting

The risk assessment and the measures taken shall be documented in a suitable form according to national law and practice.

If employees handle carcinogenic or germ cell mutagenic substances, the employer has to keep an up-to-date list of the workers engaged in the activities in respect of which the results of the risk assessment reveal a risk to workers' health or safety. That document should indicate, if the information is available, the exposure to which they have been subjected.

4.6 Check of effectiveness

In order to control the efficiency and correctness of the determined measures, different methods are available. The appropriate methods have to be chosen with regard to:

- hazardous properties of the used substances;
- systems installed; and
- operations done by the employees.

Universal recommendations ignoring the above-mentioned items are not adequate. Some specific examples are shown here:

- To check the activity of a local exhaust ventilation, a flowmeter can be used as well as a differential pressure gauge. Especially in labs, wind wheels are often used to check the exhaust, although this method is typically not appropriate for improving the effectiveness of the ventilation.
- A more precise method for checking the airborne concentration of hazardous substances is exposure monitoring of the airborne concentration. For this purpose, a wide range of methods are available. For some highly toxic substances or strong carcinogens, specific chemical analyses for a one-time measurement are available. Personal monitoring devices typically use a sampling duration over a longer period, e.g. eight hours. With a special monitoring pump, the airborne substances are pumped over a special adsorbent agent, the substances of interest are adsorbed and after eluting the adsorbed substances by using a special chemical, the concentration is detected using special analytical equipment, such as a gas chromatograph.
- Typically, closed systems can be considered to be systems of very low exposure. Firstly, fixed installed pipes or closed vessels are typically not sources of relevant exposures. Secondly, seals or pumps often show increasing leakage over longer usage durations. Such leakage can be checked using simple measurement equipment, e.g. unspecific gas chromatographs, photo ionization detectors or more specific tubes with direct indication.

The risk assessment shall be kept up-to-date, particularly if there have been significant changes which could render it out-of-date, or when the results of health surveillance show it to be necessary.

5 Safety instructions, training and information for workers

An essential precondition for safe work is proper information of workers. Employees have a right to know all about the risk assessment that has been conducted, and about the resulting actions and safety measures. This includes information on the identities, the hazardous properties and the relevant exposure limits of the chemicals that are used or that may be present at the workplace. So, the employees or their representatives must be given access to any safety data sheets provided by the supplier. In addition to giving such information, it is important to offer regular training in safe handling and behaviour, preferably on a yearly basis.

5.1 Safety instructions

It is common industrial practice to have operation procedures or instruction manuals that contain essential safety rules. When containers or pipes for hazardous chemicals are in use with reduced labelling, possibly for technical reasons, proper information and training of workers is essential to ensure that the hazardous content is at least identifiable to the workers.

A standard instruction is typically structured into several chapters, which include identification of the chemical and of the corresponding task, as well as:

- hazards to humans and the environment;
- required protective measures;
- behaviour in the event of emergency and accident;
- first-aid measures;
- suitable disposal.

These instructions are intended for the workers. Therefore, they should be written to be easily understandable by everybody. All procedures and actions are to be described concisely, clearly and practically. That is why SDSs cannot replace such instructions, but the information and the recommendations in them are the background and the main source for preparing instructions.

It is recommended to avoid overly generalised statements, such as:

- use suitable extinguishing agent;
- wear appropriate chemical-resistant gloves.

Suitable equipment must be described in a way that is generally known to all employees.

In order to gain high acceptance, it has proved very valuable to prepare instructions with worker participation.

Especially for substances of very high concern, such as very toxic substances, or strong carcinogens, individual instruction sheets for each chemical product or

the relevant operation are preferred. When workers are well-trained, instructions for a group of certain chemicals with comparable hazardous properties and handling can also be used. For example, instead of preparing individual sheets for aliphatic amines, they can be put together in one common sheet. Of course, the individual substances should be mentioned by name.

The following structure for the instructions is recommended, based on practical experience:

5.1.1 Hazards to humans and the environment

All existing and relevant hazards and risks at the workplace shall be listed, taken from the H-phrases on the label or from the safety data sheet. Additional information either from the supplier or from safety literature could be necessary.

5.1.2 Required protective measures

The type of personal protective equipment shall be described exactly. When respiratory protective equipment is to be used, differentiate between particle and vapour filters, e.g. type FFP2 particle filter or type B gas filter. When eye protection is to be used, differentiate between spectacles, goggles or a combination with a face shield. When gloves are to be used, specify the exact type or indicate the material, the thickness and always the breakthrough time. All of the information can be found in chapter 8 of the material data sheets.

5.1.3 Behaviour in the event of emergency and accident

Fundamental instructions on proper behaviour have to be given for rationally foreseeable incidents, e.g. for unintended leakage of substance, for fire, and for explosion.

Note the relevant telephone numbers (emergency number, management number), describe required actions concisely and precisely. If various different items of PPE are needed, specify them in the same way as indicated in the paragraph above. (Source: chapters 5 and 7 of the material data sheets.)

5.1.4 First-aid measures

Safety instructions are needed in the event of:

- eye contact;
- skin contact;
- inhalation;
- burning; and
- ingestion.

If specific antidotes should be used, mention that a consultation with a medical doctor is needed. The instructions given on first-aid are primarily intended for employees, not doctors (physicians). (Source: chapter 4 of the material data sheets. More information is given in chapter 3.2.)

5.1.5 Suitable disposal

Materials for binding liquids should be mentioned if appropriate. If technical tools or items of personal protective equipment have to be used, the appropriate types should be described in detail. Usually, residual amounts of chemicals are collected separately before they are given to disposal. Furthermore, it may be necessary to describe how to clean cans, containers or packaging material.

5.2 Communication and Training

Depending on individual national legislation, verbal communication plays an important role. Though there is no frequency given for oral instruction sessions, it is common industrial practice to hold such sessions at least once per year. If it is not possible to discuss all chemicals within one session, possibly due to the large number of substances used, it is recommended to teach the necessary subject matter monthly, for example. If changes are made, additional briefings may be needed. Of course, the very first instruction has to take place with new staff or before working with a new chemical. Normally, if present, the contents of the written instructions are taught. Verbal instructions aim to ensure that workers learn basic information on the hazardous properties of the chemical agents present at the workplace, and on safe handling procedures so that they know how to behave properly.

It is good industrial practice to document instruction sessions, such documents containing information about the contents of the instructions, places and dates, the names of the workers and possibly their signatures.

Instruction in correct use of personal protective equipment has to be given by the employer or a representative. In order to protect workers from an accident, incident or emergency, and in addition to the safety instructions, the employer shall perform safety drills at regular intervals.

5.3 Access to personal information

If employees handle carcinogenic or germ cell mutagenic substances, the employer has to keep an up-to-date list of the workers engaged in the activities and each worker shall have access to the information on the list that relates to him or her personally.

5.4 Helpful instruction tools provided by the ISSA Chemistry section

The ISSA Chemistry section provides a lot of information concerning hazardous substances for instruction. At http://downloadcenter.bgrci.de/shop/ivss there are video clips about "Storage of chemicals" and "Dangerous goods and hazardous substances: transport safely – work safely". At http://safety-work.org/en/topics/chemicals.html? no_cache=1 there are videos about "Labelling of hazardous substances" and "Storage of chemicals" as well as Safety instructions concerning "Handling dangerous substances", "Maintenance: Hot work – working with fire hazards", "Storage of chemicals" and "Safety signs".

6 Medical issues

6.1 First aid

In the event of accidental exposure to hazardous substances, the following first aid measures are recommended:

- Remove injured worker from the danger area.
- Remove all clothes with skin contact immediately.
- Use emergency shower or rinse skin immediately and abundantly with water for at least ten minutes, unless otherwise stated.
- In the event of unconsciousness, put the unconscious person in the recovery position.
- In the event there is no pulse, alert other people and start cardiopulmonary resuscitation.
- In the event of contact with an eye, open the eye by holding the eyelashes and rinse it abundantly with running water or use an eye shower for at least ten minutes, and then consult a physician.
- In the event of swallowing, rinse mouth abundantly with water and let the person drink water in small quantities. Do not induce vomiting, except if an occupational physician recommends it.
- Consult the safety data sheet for substance-specific measures.
- When in doubt, consult a physician.

There are some precautionary measures a rescuer has to think about, because not only the worker but also the rescuer may be in danger:

- When an asphyxiant or hazardous gas is suspected to be the reason for unconsciousness, alert other people, and do not enter the place of danger alone and without an adequate respiratory mask.
- When contaminated clothes have to be removed, be careful not to come into contact with the hazardous substance.
- When water has to be used, be careful not to be contaminated by splashing.

In the event of burns, the following first aid measures are recommended:

- Remove the patient from the heat source.
- Cool the injured area as soon as possible with cool water (if possible running water) for up to twenty minutes. If there is no water, a first aid burn gel may be used.
- Remove all clothes that are wet with hot liquids. Remove all tight clothes, watches, and rings because the affected body parts may swell.
- Call a physician if the burning involves the eyes or if the affected area is more than half of the patient's arm. A physician should be consulted if the patient suffers ongoing pain, or if the burning involves the face, hands, joints or genitals.
- After cooling the affected area with water, place a sterile non-adherent dressing on the skin. Do not use adhesive tapes and do not apply creams, ointments etc.

6.2 Medical examination

Despite all protective measures, it is possible that exposed workers might suffer damaging health effects due to contact with chemicals. Depending on the risk assessment and the country's regulations, exposed workers may be or have to be included in a preventive occupational medical programme. The aim of such a programme is to prevent an occupational disease or to detect an occupational disease at an early stage. Preventive occupational medical programmes are not a general check-up for health, but rather they are specifically tailored to the possible damaging effects of a hazardous substance. The costs of the preventive occupational medical programme have to be paid by the employer.

A programme can comprise different parts such as anamnesis, clinical investigation, instrumental investigation (e.g. X-ray or spirometry) or biomonitoring. Biomonitoring consists in determining the concentration of the hazardous substance (or one of its metabolites) in urine, blood or another biological material. Instead of the substance, a stress indicator like certain liver enzymes or inflammatory markers can be measured. Biomonitoring takes into account all possible routes through which a hazardous substance can be absorbed (respiratory tract, skin, mouth). Therefore, biomonitoring is a holistic approach, in contrast to ambient measurements like air monitoring.

Medical programmes ideally begin before the beginning of an occupation and are continued at regular intervals. The programme may continue after termination of the exposure for substances that have long latency times between start of work and occurrence of disease (e.g. carcinogenic substances) or when a disease has developed before the end of exposure. In some occupations like divers, crane drivers or workers at hot workplaces, a medical investigation has to be done mandatorily before they start working.

Depending on the results of the medical investigations, the physician decides whether the worker is fit to work in a specific occupation, whether further medical examinations need to be conducted, whether the worker has to use special safety precautions like personal protective measures, or whether the worker is no longer allowed to continue in his or her occupation. The physician's decision is explained to the worker and – depending on the national regulations – to the employer. However, the health results of the medical examinations must never be disclosed to the employer (medical confidentiality). According to the outcome of the risk assessment of carcinogenic and germ cell mutagenic substances, exposed workers have to be medically examined regularly under a preventive occupational medical programme. This programme may continue both after the end of exposure and also during the retirement of the worker.

About ISSA

Providing social security

The International Social Security Association (ISSA) is the world's leading international organization for social security institutions, government departments and agencies.

Social security may be defined as any programme of social protection established by legislation, or any other mandatory arrangement, that provides individuals with a degree of income security when faced with the contingencies of old age, survivorship, incapacity, disability, unemployment or rearing children. It may also offer access to curative or preventive medical care.

The ISSA was founded in 1927 under the auspices of the International Labour Organization, and today has over 320 member institutions from over 150 countries.

Preventing work related risks

The Special Committee for Prevention plays an important role within the ISSA. It consists of 14 international sections and deals with work-related risks in various sectors such as chemical industry, mining, electricity and transport, but also with cross-cutting issues such as machine and system safety, Information and prevention culture. The Special Committee coordinates the joint activities of the international risk prevention sections and other ISSA prevention activities.

As one of the first sections of the Special Committee, the International Section for Prevention in the Chemical Industry was founded in June 1970 in Frankfurt am Main. It is committed to the prevention of accidents at work and occupational diseases in the chemical and related industries, in particular in the fields of plastics and rubber, varnishes and paints, pharmaceuticals and cosmetics, as well as specialty chemicals and petroleum processing. ISSA Chemistry is chaired by German Social Accident Insurance Institution for the raw materials and chemical industry (BG RCI).

Chemical Industry | Machine and System Safety | Transportation | Construction Industry | Information | Mining Industry | Agriculture

Communicating expertise

A special thematic focus in the chemical industry is the handling of hazardous substances and the resulting health and explosion hazards. In 1978, therefore, the two working groups "Dangerous Substances" and "Explosion Protection" were formed in the Chemistry Section.

The working groups are engaged in intensive informal discussions, brochures and instruction media are developed, workshops are organised to promote an international exchange of experience among experts and to promote selected problems to develop targeted solutions.

In this way, the Chemistry Section wants to contribute to a high state of the art comparable among industrialised countries and to pass on its knowledge to even less developed countries.

Imprint

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Section on Prevention in the Chemical Industry

Ready to use hazardous substances?

Important steps to handle such chemicals safely

Using hazardous chemical agents can lead to risks to the safety and health of workers, such as irritation, poisoning, and burns. Long-term effects, emanating, for example, by carcinogenic agents, can cause occupational diseases. Furthermore, chemical agents with physical hazards have the potential to cause accidents like fire and explosion. Chemical agents with hazards for the environment can constitute risks for aquatic life and the ozone layer.

In this context it is very important to implement risk assessment as a key element of occupational health and safety in every company. This brochure explains the most relevant aspects when handling hazardous substances. The brochure is addressed, in particular, to trained first-line supervisors or "foreworkers" in small and medium-sized enterprises and other persons who have to instruct employees on this topic and raise awareness about health hazards when in contact with chemicals.

The "Dangerous Substances" Working Group of the ISSA Chemistry Section is concerned with current topics regarding chemical agents, and develops products that are designed to support enterprises, especially small and medium-sized enterprises (SME), in assessing hazards and developing appropriate protective measures.

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