

Storage of chemicals

Guidelines for good practice



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Section on Prevention in the Chemical Industry



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- Plastics
- Rubber
- Pharmaceuticals
- Lacquer
- Paints
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Storage of chemicals

Guidelines for good practice

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Preface

This brochure provides information on risks related to the storage of chemicals and gives advice on appropriate precautions.

In the fourth edition of this brochure a complete revision was made and, among others, the recommendations of the United Nations on the globally harmonized system of classification and labelling of chemicals (GHS) have been incorporated.

The board of the ISSA Chemistry Section would like to build on the successful distribution of the previous editions.



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1 INTRODUCTION

INTRODUCTION

How are chemicals safely stored?
This question is relevant not only in chemical plants; the products in the following examples are also chemicals:

- Paint and varnishes of a painter workshop,
- Cleaning and disinfecting agents of a cleaning company,
- Oils, solvents and thinners in a repair shop,
- Building foams, cement residue remover of a construction company,
- Gas bottles with acetylene, oxygen, liquefied gases of a locksmith.

This brochure shall give a practical guide to where and how chemicals should be kept, in particular for small and medium-sized enterprises.

In the following, general requirements on the storage of chemicals are described. Requirements for hazardous substances with specific properties are summarized in Chapter 7.



EU Directive 67/548/EEC	Regulation (EC) 1272/2008 (CLP)	UN Recommendations on Transport of Dangerous Goods (UNDG)

Dangerous substance labelling in accordance with different classification systems

2 SCOPE AND OBJECTIVES OF THIS BROCHURE

SCOPE AND OBJECTIVES

The focus of this brochure is the storage of chemicals, particularly hazardous substances.

Hazardous substances are

- Liquids,
- Gases or
- Solids,

which may affect

- as pure substances or
 - as mixtures
- due to their
- physical-chemical,
 - health endangering or
 - environment endangering properties
 - human beings,
 - the environment or property values

Usually, hazardous materials are recognized by their hazard symbols or pictograms. The figure on page 9 gives an overview of possible hazardous material labels.¹

¹ For symbol/pictogram's meaning see chapter 7

NOTE: In addition to hazardous substances which are marked with a symbol or pictogram, there are also chemicals that need not be labelled, but can be potentially dangerous. Hazardous substances include waste, depending on the composition. ■

This brochure is concerned with the storage of chemicals in packages or portable container up to 1000 Litres. Within the framework of this brochure, the term storage means keeping goods in a place for more than 24 hours, irrespective of the location.

For hazardous substances that are kept at the workplace or are kept in so-called temporary storage facilities for the production requirements, equivalent precautions for safe storage should be taken.

NOTE: The storage of hazardous substances and mixtures in Europe is subject to national regulations, which may differ in some details. ■

The target group are all people who are involved in the storage of chemicals. This brochure is aimed primarily at warehouse foremen, and all employed people in the storage facilities. Specific knowledge of chemistry is not required.

The following items are not in the scope of this brochure:

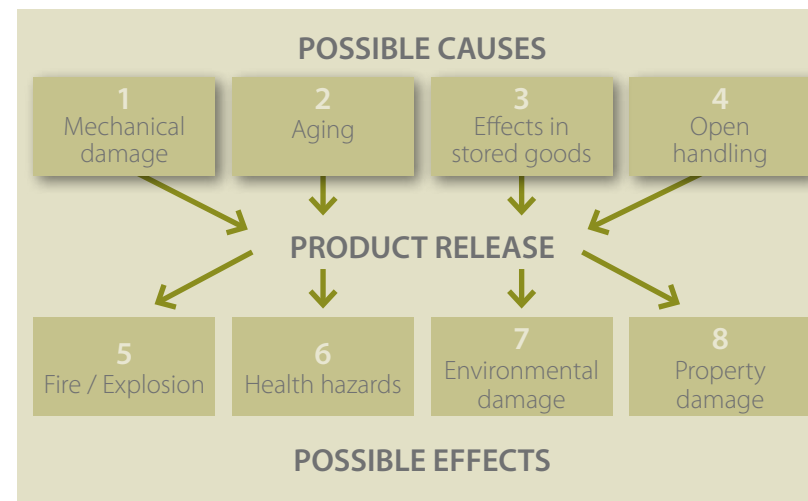
- Specific measures for explosives, organic peroxides, radioactive and infectious substances.
- Risks related to transportation (while the transport labelling is used as an indication of potential danger)
- Manual operations such as filling and decanting or transferring. These go beyond simple storage and are subject to specific regulations on the use of chemicals. These activities will therefore be considered only briefly in this brochure.

3 HAZARDS RELATED TO STORAGE OF CHEMICALS

Risks occur primarily when chemicals are released as a result of a leakage.

Possible causes are:

- 1 Mechanical damage of containers or shelves
 - In-house transport, possibly in conjunction with inadequate lighting.
 - Excessive or risky stacking
 - Overloading of shelves
 - Uneven or sloped floors in the storage room ► Tilting or tipping of stored goods
- 2 Physically or chemically induced aging of the containers or shelves
 - Duration of storage ► Decrease in elasticity and brittleness of plastics
 - Light, particularly UV radiation ► plastics becoming brittle
 - Cold ► Decrease in elasticity and brittleness of plastics, metals becoming brittle
 - Heat ► softening of plastics
 - Reactive atmosphere ► Corrosion of metallic materials
 - Interaction of the container material with stored goods
- 3 Physically or chemically induced effects in stored goods
 - Cold ► Crystallization, cracking of bottles with aqueous solutions,
 - Heat ► Increase of internal pressure due to vapour pressure, triggering



- of a decomposition in thermally instable products
- Light, particularly UV radiation ► triggering of violent reactions in substances forming peroxides or products, which may polymerise
- Duration of storage (including transportation time) ► Triggering of a degradation in thermally instable products
- 4 Open handling
 - Filling and decanting
 - Leaving open
- 5 Fire / Explosion
- 6 Health hazards
 - Irritation
 - Poisoning
 - Burns/corrosion
 - Burns due to heat and cold
 - Sensitizing
 - Breathlessness
 - Suffocation
- 7 Environmental damage
- 8 Property damage

In addition to the acute hazards to health, which are important in case of a leakage, chronic effects have to be considered in the case of prolonged or repeated exposure.

Possible effects are:

4 ORGANISATION AND OPERATION OF THE STORAGE ROOM

ORGANISATION AND OPERATION

4.1 STORAGE CONCEPT

The storage concept represents an overall view of all storage safety aspects. It is used to detect potential safety-related deficiencies and can be used as a basis for the approval and licensing procedures. It includes:

- a description of local conditions and surroundings,
- the characterization of storage room construction including the fire protection concept,
- the technical and organizational measures,
- the definition of zones for potentially explosive atmospheres or the reference to the explosion protection document,
- the type of storage and the definition of the types of containers to be stored,
- properties, quantities and storage classes of chemicals to be stored.

4.2 RISK ASSESSMENT

The aim of the risk assessment is to identify all risks for people and the environment. Derived from these risks, the necessary protective measures are defined. The documentation of the risk assessment can be integrated in the storage concept.

4.2.1 Source of information

The main information sources for risk assessment for the storage of chemicals are:

- labelling,
- the actual version of the safety data sheet,
- supplementary information from the manufacturer,
- publications and databases of prevention institutes and organizations,
- relevant literature.

4.2.2 Work processes and operating conditions to be considered

As part of the risk assessment for the storage of chemicals the following points should be considered:

- Delivery and shipping,
- Placing in stock,
- Removing goods from stock
- Storage,
- Transportation inside the storage facilities,
- Removing of released chemicals.

Uncleaned empty containers and partially empty containers require special attention, as for instance, explosive air-gas mixtures can be formed when flammable liquids are within these containers. These vessels have therefore to be treated as if they were full, but should be stored separately from other containers and clearly labelled.

If chemicals are being filled and transferred, the storage room becomes a work area. Therefore it has to fulfil the respective requirements. Depending on the type of chemicals additional measures are required.

4 ORGANISATION AND OPERATION OF THE STORAGE ROOM

4.2.3 Potentially explosive atmospheres²

If mixtures of air and flammable gases, vapours, dusts or powders may occur, the following points must be addressed in the risk assessment:

- the possibilities of the formation of explosive atmospheres have to be identified,
- potentially explosive areas have to be declared as Ex- zones and
- protective measures have to be established.



Escape routes must not be blocked

4.3 BASIC REQUIREMENTS AND MEASURES

4.3.1 Storage places and rooms

Chemicals must never be stored in places where they may lead to an increased danger to people. Such places are in particular circulation routes, including stairways, corridors, emergency exits and escape routes, narrow passages and narrow courtyards.

Inappropriate places for storage are, among others, recreation areas, standby staff rooms, restrooms, medical stations or daytime accommodation, residential and retail rooms as well as basements of residential buildings.

² Further information on this issue are found in chapter 6 „Machinery, equipment and facilities“

4.3.2 Requirements for containers and packaging

Containers and packaging for chemicals must be sufficiently resistant against mechanical, thermal and chemical impact related to (internal) transport and storage.

These requirements for example met, if the packaging or container requirements for the transport of dangerous goods are fulfilled (transport packaging according to ADR / RID).

Chemicals should be stored in original containers. If chemicals are not stored in original containers, it has to be ensured, that storage containers are suitable and correctly labelled. Hazardous materials shall be stored only in closed packages or containers.

As a minimum the substance name must be indicated on each container or package. In addition, hazardous substances and preparations/mixtures must be labelled with the respective hazard symbol (pictogram) as well as the hazards phrases, and precautionary statements.

Chemicals must not be stored in containers or packages that could be mixed-up due to their form or labels with containers or packages which contain food.



Chemicals should be stored in original containers

Packaging and containers that are provided with “upward labels” must be stored accordingly.

4 ORGANISATION AND OPERATION OF THE STORAGE ROOM

4.3.3 Stack height

The maximum stack height must be chosen so that there is no risk of falling containers. The following points must be taken into account:

- Stacking restrictions for certain packages (e.g. for cantilevered IBC),
- The mechanical stability of the bottom container in relation to the load above (especially for carton/cardboard packaging),
- the mechanical resistance of the container at the top in the case of falling (especially for bottles),
- The risk to workers by tilting stacks (in particular due to mechanical damage of the container at the bottom).

It is recommended to limit the stack height to 3 Metres.

4.3.4 Storage Plan / Stock List

To manage the warehouse a storage plan with detailed information on the location and the amounts of different chemicals has to be established. In the event of fire or leakage the plan will allow to quickly determining the type of stored products and the exact quantities.



Containers must be fixed

The storage plan should include:

- Description of stored chemicals,
- Classification of chemicals or data related to their hazardous properties,
- The maximum total storage volume and the actual quantity, sorted by meaningful risk criteria, for instance, by hazard class, substance class, storage class,
- Indication of the storage compartments, which contain the different chemicals.

4.3.5 Combined storage

Chemicals may not be stored together, if this increases the risk. For instance when,

- different extinguishing agents are needed³,
- different temperature conditions are required,
- the simultaneous release and interaction may result in the formation of flammable or toxic gases.

³ The use of the wrong extinguishing agents in the case of fire fighting dangerous reactions may be triggered with the extinguishing agent. This is especially relevant when storing chemicals together, which require different extinguishing agents, as there might not be the adequate extinguishing agents for all chemicals.

NOTE: Information on combined storage and incompatibilities with other chemicals are found usually in the product's safety data sheets in sections 7 "Handling and Storage", 10 "Stability and Reactivity" 15 "Regulatory Information" and 16 "Additional information". Information about the reactivity of hazardous substances with specific properties can also be evaluated in test laboratories. ■

Drugs, food or animal feed, cosmetics and stimulants must not be stored in the same area as toxic and very toxic chemicals (acute toxic substances of category 1-3), carcinogenic, mutagenic and reproductive toxic⁴ chemicals.

All other substances must not be stored in the immediate vicinity. It is recommended to observe a minimum distance of 2 meters.

⁴ Toxic reproduction toxic means impairment of fertility as well as harm to the unborn child.

4 ORGANISATION AND OPERATION OF THE STORAGE ROOM

Storing chemicals with different hazardous properties together may lead to dangerous reactions in case of simultaneous leakage and mixing. For instance:

- Chemicals may react with each other and produce toxic gases, like acids and chlorites.
- Acids and bases could violently react with each other and cause splashes.
- Contact of flammable and oxidizing chemicals may cause fires or even explosions.

Such “incompatible” chemicals must be kept separately from each other. Furthermore, measures must be taken to prevent that they come in contact in the case of a leakage. Depending on the stored quantity containers have to be placed in separate catch pans or in different storage compartments separated by fire walls.

When preparing goods for delivery and commissioning, the mixed loading rules for transportation have to be observed.

4.3.6 Managing the residence time in a storage area

Due to the chemical instability of some substances and the limited life of packaging and containers, the exchange of goods in a storage area must be managed rigorously. As far as possible, the stored stocks have to be demand-driven and the oldest product the first to be used (First In First Out policy).



Storage in order

4.4 ORGANISATIONAL REQUIREMENTS AND MEASURES

4.4.1 Responsibilities and tasks

Employer

The employer is responsible for the safety and health of employees and the protection of the environment. This includes but is not limited to:

- Development of the storage concept and carrying out a risk assessment.
- Maintaining contacts to authorities.
- Compliance with safety regulations and control of the specific storage conditions required by the properties of products, for instance, by inspections with safety officers and security personnel.
- Assignment of a logistic manager with appropriate qualification in chemical product safety and/or transport of dangerous goods.
- Selection of suitable employees and care for their further training.
- Collection of information on the material properties. For all stored hazardous substances updated safety data sheets must be available and accessible to employees.
- Provision of personal protective equipment to employees and

enforcement of regular maintenance for this equipment.

Logistic manager

By delegation from the employer the following tasks arise and apply to the logistic manager:

- inform the employer, if the information related to storage in the safety data sheets is not sufficient or if a risk assessment needs to be accomplished or updated.
- Implement and control the measures resulting from the risk assessment.
- Check the labelling of incoming containers and compare it with the shipping documents.
- Check incoming and stored container for damage or leakage and if necessary, take corrective actions.
- Set-up and update the storage plan.
- Establish operating instructions and train the employees.
- Develop an emergency plan and keep it up to date.
- Check safety installations and systems regularly, initiate tests if necessary.

4 ORGANISATION AND OPERATION OF THE STORAGE ROOM

Employees

For employees, the following tasks apply:

- Carry out the work meticulously in accordance with the standard operating procedures and instructions.
- Use and maintain personal protective equipment.
- Inform immediately the manager about incidents, near-misses and safety relevant observations, such as damaged packaging, spills, fires and accidents.
- Support the employer in matters of health and occupational safety.



Operating instructions give advice for a safe handling of chemicals

4.4.2 Operating instructions and training

For storage and related activities written operating instructions must be available. Employees should be trained by the supervisors on the basis of these operating instructions. Contents of operating instructions/manuals/guidelines and related training are:

- Labelling of hazardous chemicals.
- Risks associated with the handling of hazardous chemicals.
- Technical, organizational and personal protection measures and rules for safe behaviour.
- Advice on rules for combined storage.
- Emergency procedures, for instance, instructions in the event of a leakage or a fire.
- First-aid measures.
- Disposal of waste products.

Operating instructions can be created for specific chemicals as well as for groups of substances with similar properties.

Other hazards arising from storage operations, for instance, due to the use of forklifts, must also be considered in the training programs.

4.4.3 Safe Behaviour

Measures that must be observed by the employees should be included in the operating instructions. Furthermore, it is essential that:

- smoking is prohibited in the storage area.
- appropriate signs on the wearing of personal protective equipment are posted.
- food, beverages and stimulants are not consumed in the storage area.
- hand washing is mandatory before breaks.
- access to the storage area is controlled depending on the properties of chemicals stored.

- warnings on special risks such as fire and explosion are displayed.
- ignition sources, which can lead to fires or explosions are avoided. Auxiliary materials and waste may act, as well, as effective ignition sources (for instance, oil-soaked rags).
- containers and packages are not damaged and fire protection installations are not destroyed or limited in their function when moving goods in the storage area.



Warning and advice labels

4 ORGANISATION AND OPERATION OF THE STORAGE ROOM

4.4.4 Hygiene

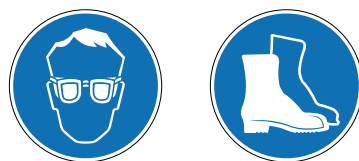
The employer must provide the necessary resources for the personal hygiene of workers. These include:

- Sanitary facilities,
- Washing bins and, if possible, showers
- Recreation rooms,
- Facilities to keep working clothes separated from private clothes, where a risk of contamination prevails.

Working clothes contaminated with chemicals must not be worn in clean areas such as offices, seminar rooms or canteens.

Storage rooms must be cleaned regularly, for instance, by hoovering. Sweeping with the broom has to be avoided, as this raises up dust particles. Dust deposits are preferably removed with industrial vacuum cleaners or vacuum sweepers. The type of vacuum cleaner and the filter quality has to be selected depending on the substance properties.

4.4.5 Personal Protective Equipment



Despite technical and organizational safety measures wearing of appropriate personal protective equipment (PPE) may be required, for instance, for contaminated containers, during storage above head height and leakage. The protective equipment (depending on particular requirements: protective gloves, safety shoes, helmet, safety glasses, goggles, face shield, protective clothing, respirators) must be appropriate for the task and the potentially released chemicals and it must be made available to all potentially exposed workers.

Protective equipment must be worn by the employees according to instructions; the supervisor has to control compliance with this rule.

For the proper functioning regular maintenance (and cleaning if necessary) is required. Defective PPE must be replaced and safely disposed by the employer.

4.5 TESTING

Storage facilities must be checked initially and periodically in appropriate intervals to ensure adequate functioning, reliability and effectiveness.

As suitable complementary organizational measures, daily function controls can be applied, including:

- Visual checks, for instance, on good operational condition of openings for ventilation,

- Hearing checks, for instance, listening for dropping liquids or trickling solids..

Checklists for testing of safety measures may be a useful tool.

Facility	Testing parameters
Storage containers	Mechanical integrity and tightness
Storage facilities	Compliance with maximum loads for shelves and bays with hazardous material containers, mechanical integrity of shelves
Retention facilities	Mechanical integrity and tightness of catch basins
Disposal facilities	Tightness and absence of corrosion of solvent waste containers
Ventilation equipment	Mechanical integrity of ventilation ducts

4 ORGANISATION AND OPERATION OF THE STORAGE ROOM

4.6 OPERATIONAL FAILURES AND EMERGENCIES

4.6.1 Emergency Plan

Each storage facility must have an emergency plan where the sequence of actions to be taken in case of fire, accident and product release / leakage is clearly defined.

When storing chemicals, with a high hazard potential, such as highly toxic and toxic chemicals (acutely toxic substances of category 1-3), carcinogenic, mutagenic and reproductive toxic, as well as, flammable or oxidising, the following information should be included in the emergency plan:

- Information on fire alarms, safety equipment, emergency exits and escape routes, assembly point, and the head-count in case of an evacuation.
- Sequence of actions to be carried out .
- Phone list containing the numbers of: emergency services, fire brigade and police, hospital, physician, Toxicology Centre.
- Phone numbers of the plant manager, supervisor and other people having operational responsibility.

The Emergency Plan must be posted clearly visible in the storage area.

Depending on the size of the warehouse and the stored chemicals, regular exercises must be carried out to train people in the alarm and emergency procedures. People should be made familiar with the correct behaviour in case of a chemical release, a fire or another emergency. They should know how to escape or be rescued. The necessity to perform emergency exercises and the respective intervals have to be defined in the risk assessment.

4.6.2 Actions in case of leakage

If chemicals are released, the measures defined in operating instructions must be followed and if necessary the supervisor must be informed.

For removing and cleaning up chemicals the required personal protective equipment (e.g. gloves, safety shoes, goggles, face shield, protective clothing, respirators) must be used.

Contamination of the sewer system with chemicals must be prevented by

appropriate measures. When only small amounts of liquid are spilled, a suitable absorption agent may be used. The collected waste must be disposed properly.

4.6.3 Consultation with authorities

Depending on the hazard potential of the storage, it is necessary to involve the authorities in the emergency planning. The need for joint planning has to be discussed with the fire department or any other competent authority.



Adsorbant and spill cover

5 PLANNING AND CONSTRUCTION

PLANNING AND CONSTRUCTION

Depending on the type and amount of chemicals, the storage area must be located in specially designated buildings. Warehouses for chemical storage should not be built close to residential areas.

5.1 APPROVAL

The storage of chemicals may generate a risk to the environment. Therefore, a storage facility has usually to be approved by authorities. Type and quantity of chemicals determine if the storage is subject to national legislation and if the approval or authorization process is required.

As a rule, compliance with certain minimum requirements for storage design and operation is required, to obtain an operating licence.

5.2 LOCATION

The selected location must meet certain geological requirements: the chemical warehouse must be on firm standing ground, moreover, it must be protected against flooding.

When storing temperature-sensitive chemicals and liquids with high vapour pressure excessive heating should avoided, for instance, by orientating the storage area to the north.

Storage activities should preferably be performed at ground level; otherwise this point has to be specially considered in the risk assessment.

Chemicals may only be stored in working areas, if the safety of people is not jeopardized and if special facilities, such as safety cabinets for chemicals are available. On the other hand, the storage areas should not be placed too far away from the rooms where the chemicals are used, such that there will be no need for interim storage and hazards related to internal transport of chemicals is minimized.

5.3 STRUCTURAL FIRE PROTECTION

The storage room must be constructed with non-combustible materials; openings (doors and windows) must meet fire protection requirements. The building must withstand the effects of an external fire, like flying embers and radiation for a sufficient period of time.

If there is a risk of poisoning or suffocation due to fumes, smoke and heat venting facilities must be installed.

Storage areas have to be equipped with adequate and appropriate fire fighting equipment (e.g. fire extinguishers, fire hydrants, and fire extinguishing systems). If fire fighting measures are not automatically triggered, they should be clearly marked easily accessible and simple to operate. Attack routes for fire brigade must be labelled and designed to allow a fast access with fire fighting equipment.

A sufficient amount of extinguishing water must be available. If stored chemicals require the use of other extinguishing agents, these have to be already available on-site and in sufficient quantity.

5 PLANNING AND CONSTRUCTION

Extinguishing water lines, sprinkler heads or smoke detectors must be installed such that they are not damaged during storage and retrieval of the stored goods.

With appropriate measures for retention of extinguishing water, contamination of the environment or the sewage drains has to be prevented.

Buildings must have a suitable lightning protection.

5.4 CONSTRUCTION MATERIALS

Depending on the stored chemicals, chemical-resistant materials must be selected and

- Surfaces have to be easy to clean and antiskid,
- The floor coating has to be tight for water and chemicals,
- The floor must be designed so that released liquids (including liquefied gas) are prevented from flowing away in an uncontrolled way,
- The storage rooms have to be equipped with drains that are not directly leading into the sewage system.

5.5 ACCESS AND TRANSPORT ROUTES

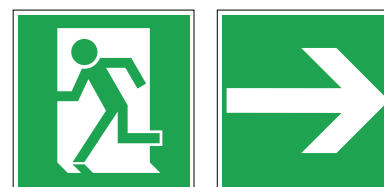
Access to chemical storage and traffic routes must be designed so that the storage and retrieval of products, as well as, the rapid intervention of emergency services is possible without complications. Stairs and steps directly in front of the storage entrance have to be avoided.

Doors and corridors must be wide enough to support the safe manoeuvring of trolleys, and, if necessary, allow the operation of forklifts.

Access to chemical storage should be permitted only to authorized people.

Traffic routes within the storage must be marked.

5.6 DOORS AND ESCAPE ROUTES



Signs for escape routes

The number of emergency exits and the maximum length of the escape routes is defined depending on the chemicals stored and the storage size.

To ensure a quick evacuation of people in case of an emergency, all emergency exits and escape routes must be clearly labelled and kept clear at all times.

Opening of emergency exit doors from the inside must be easy and without requiring any key (for instance, using anti-panic bars). The emergency exits must open outwards.

5.7 STORAGE IN THE OPEN AIR

Chemicals may be stored in the open air/outdoors,

- if the containers are weather- and water-proof, or,
- if the storage locations are roofed adequately.

Hazardous chemicals must not be washed away by rain water into drains or to the environment. Rain water drains must be equipped with shutters so that they can be closed in case of an accident.



The storage area must not be accessible to unauthorized people

For chemicals with restrictions for combined storage, adequate safety distances have to be kept.

The rules for storage in building shall be applied in an analogous way.

6 MACHINERY, EQUIPMENT AND FACILITIES

MACHINERY, EQUIPMENT AND FACILITIES

6.1 LIGHTING AND ELECTRICAL INSTALLATIONS

In the storage area, sufficient lighting has to be provided. The lamps must be mounted in a way that heating of the stored goods is avoided, particularly if this may lead to a dangerous reaction.

The lighting should be designed so that all storage locations are clearly visible and that labels/symbols are easily legible. A luminance of 300 lux is recommended. Lamps should be positioned in the aisles between the shelves.

NOTE: Since lighting and electrical installations are to be considered as ignition sources, they must be appropriately certified when installed in Ex-Zones.

6.2 STORAGE SYSTEMS

Shelves and cabinets should preferably consist of non-flammable materials. They must have the required chemical resistance to the stored goods and mechanical stability according to the design load. They must be mounted in a stable way, e.g. fixed at the wall). The maximum shelf load must be clearly indicated.

Shelves must be built preventing the drop of the products. Packaging and containers - especially if they may break - should be stacked and secured, such that they cannot fall from the shelves. Storage cubicles should not be too deep in order to ensure that stored products remain clearly visible and easily accessible.

The containers must be stored in shelves, cabinets and other facilities only up to a height which allows safe storage and removal. If necessary, the use of forklifts or auxiliary devices such as steps, ladders or platforms may have to be used. It is important to ensure that within a shelf, the heaviest loads are placed at the bottom.

When using vehicles such as forklifts or picking devices, an adequate collision guard must be installed around the shelves.



Indication of shelf loads

6 MACHINERY, EQUIPMENT AND FACILITIES

6.3 RETENTION FACILITIES

Chemicals must be stored so that a leakage can be easily identified and that the released substances can be absorbed and removed. This is achieved, for instance, with a bund, basin or a similar collection space made of chemically resistant material. Such a retention systems must not be directly connected to the sewage drains. The capacity has to be adjusted to the stored volume. It is useful to provide a pump sump, so that in the event of a leakage, the pumping action can be easily performed.

For small spills of liquids, a suitable absorbent material should be available and easily accessible (see also section 4.6.2 "Actions in case of leakage").

6.4 VENTILATION

The storage rooms must have a ventilation system to ensure that no hazardous conditions for people are generated during normal operation and in the event of a credible product leakage.

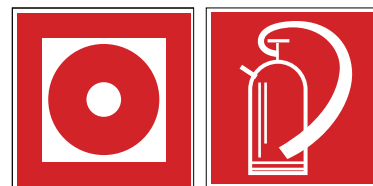
Natural ventilation is possible if the size and location of openings ensure a sufficient air draft.

6.5 AIR CONDITIONING

Frost or high temperatures may affect some products and container materials leading to irreversible changes or damage or to a pressure build-up. Information on safe storage temperatures can be found in section 7 of products' safety data sheets. These conditions must be taken into account.

If portable heaters are used in the storage area, it is necessary to perform a specific risk assessment. In particular, radiation heaters must be located and operated in a way which does not result in a punctual or increased localized heating of the stored goods.

6.6 FIRE FIGHTING



Signs for fire fighting

Fire prevention measures must focus on the avoidance of ignition sources, the quick control of an emerging fire and the evacuation of people.

In the event of a fire, the emergency services must be alarmed immediately with smoke or fire alarms, emergency push-buttons or telephones and people in the warehouse and possibly on the site must be warned.

In addition, extinguishing agents must be available inside and outside the storage area. These are, for instance, powder or carbon dioxide fire extinguishers.

6.7 SAFETY CABINETS

Safety cabinets are used to store closed containers containing chemicals and may also be placed in workrooms. They are particularly suitable for the storage of flammable liquids.



Safety cabinet for flammable liquids

6 MACHINERY, EQUIPMENT AND FACILITIES

The safety requirements for solvent cabinets are met if they fulfil the EN 14470-1 (Fire safety storage cabinets - Part 1: Safety storage cabinets for flammable liquids). If possible, safety cabinets should be connected to the ventilation system. The doors of safety cabinets must always close by themselves. This function must be tested regularly.

Any leakage of liquids must be collected in the safety cabinet and then quickly identified and removed. The drip pan of a safety cabinet must be able to collect 10% of the volume of all stored vessels or the volume of the largest vessel, whichever larger.

6.8 EXPLOSION PROTECTION

NOTE: *In this chapter only the very basic measures for explosion protection for storage of chemicals are outlined. Further details on the numerous measures required in an explosion protection concept can be taken from the ISSA brochures on Explosion Protection.*

Flammable gases, flammable liquids and their vapours as well as dusts of combustible solids, can form an explosive atmosphere with air, in case of leakages and especially during transfer. In the presence of ignition sources, such as hot surfaces, open flames, mechanically generated sparks, electrical equipment, static electricity⁵ and lightning, there is a risk of ignition of the explosive atmosphere.

The prevention of explosions in storage facilities is focussed in particular on the avoidance of potentially explosive atmosphere and the elimination of ignition sources.

- The formation of an explosive atmosphere can be prevented by storage of dangerous goods in approved, tightly sealed containers. Additional measures must be taken, such as regular controls of tightness, prohibi-

tion of open handling and precautions against damage of containers by dropping or by transportation. If the risk assessment reveals that a leakage of flammable substances cannot be reliably excluded, the formation of an explosive atmosphere has to be taken into account. Should this happen, the formation of an explosive atmosphere has to be restricted by adequate ventilation. This ventilation must be effective in the entire room, and, especially, close to the floor, where the vapours of flammable liquids or gases may accumulate as most of them are heavier than air. The ventilation, for instance, can be activated and controlled by a gas detection device.

- In areas where explosive atmospheres can occur, ignition sources such as open fires, smoking, hot surfaces, static electricity, sparks and non-explosion-proof electrical equipment must be avoided.




⁵ Electrostatic charges have to be expected in the case of fluid leakage, when walking with isolated shoes and in the case of the charging of non-grounded objects.

7 SPECIAL STORAGE REQUIREMENTS FOR HAZARDOUS SUBSTANCES WITH SPECIFIC PROPERTIES

SPECIAL STORAGE REQUIREMENTS

This chapter complements the general requirements for the storage of chemicals with specific measures for specific hazards. The measures described do not replace the need to perform a risk assessment as described in Section 4.2.

For a safe storage of chemicals it is essential to have a comprehensive knowledge on the hazardous properties. Important initial information can be obtained from the symbols on the package labelling. This may - as shown by the example of ethanol - be organized in terms of different legal frameworks:

Labelling	Important elements of identification		
According regulations for transportation on road, rail, sea or by airplane, with the UN rules as a base. For the road transportation in Europe, this is ADR, related to dangerous classes ⁶ .		Symbol	Transportation regulation
	UN 1170	UN-number	
According to the Globally Harmonised System (GHS), where hazardous substances are classified in 28 hazard classes ⁷ .		Hazard pictogram	Chemical regulation
	Hazard	Signal Word	
	H225: Highly flammable liquid and vapour.	Hazard Phrase (H-Phrase) Precautionary Statements (P-Phrase)	
According to Directive 1999/45/EC on the classification of mixtures. It is still applicable until mid-2017.		Symbol	Chemical regulation
	F	Symbol Letter	
	R11: Highly flammable.	Risk Phrase (R-Phrase) Safety Advice (S-Phrase)	

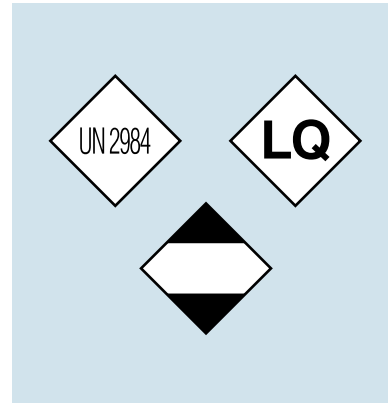
⁶ Other transportation (e. g. sea- or inner sea journeys) use different risk and dangerous goods information, but the picture/symbol information as such is the same one in use.

⁷ In Europe the GHS is applied through the Directive (EG) No. 1272/2008 (CLP-Directive).

7 SPECIAL STORAGE REQUIREMENTS FOR HAZARDOUS SUBSTANCES WITH SPECIFIC PROPERTIES

NOTE: Within the transportation rules small packages are not labelled, following the so-called „limited-quantity control“, but one of symbols shown here. In this case the relevant information must be taken from the respective Safety Data Sheet.

The safety data sheet provides detailed information on the dangers associated with a hazardous substance. Therefore it should always be used for evaluation.



7.1 TOXIC CHEMICALS AND CMR- SUBSTANCES

Toxic chemicals can cause serious health damage or even lethal effects in very low amounts.

CMR substances are carcinogenic (cancer causing), germ cell mutagenic or re-pro-toxic (may impair fertility or harm the unborn child).

Labelling elements	Dangers
	(Very) toxic, life-threatening by ingestion, inhalation or skin contact.

Labelling elements	Dangers
	May cause cancer. May cause genetic defects. May damage fertility or the unborn child. May cause damage to organs.

Special Measures:

Chemicals with these classifications must be under lock and key, or stored so that only qualified people have access. The restricted access must be clearly and


permanently visible with the prohibition sign "No access for unauthorized persons".

7 SPECIAL STORAGE REQUIREMENTS FOR HAZARDOUS SUBSTANCES WITH SPECIFIC PROPERTIES

7.2 GASES AND AEROSOLS (AEROSOL PACKAGING)

Among the gases and aerosols are:

- compressed gases
- liquefied gases
- refrigerated liquefied gases
- dissolved gases
- flammable gases
- toxic gases

Labelling elements	Dangers
	<p>Gases under pressure may explode when heated.</p> <p>Refrigerated liquefied gases can cause cold burns or injuries.</p> <p>In case of rupture in a fire or due to an accident gas bottles can become devastating projectiles, which can fly over several hundred meters.</p> <p>NOTE: If gases and aerosols are also toxic or flammable, additionally, the instructions in the relevant chapters have to be taken into account when developing a storage concept.</p>

Special Measures:

Compressed gas containers must be secured against tilting or falling. The valves must be protected with a suitable device, for instance, with a protective cap or basket.

Gases are best stored outside buildings. If they are kept in rooms, these must have adequate ventilation. Warning signs should make aware of the suffocation hazard.

In order to prevent the dangerous accumulation of gases, no pits, trenches or basement entrances should be in the area where gases, which are heavier than air or which are liquefied, could spread in case of a leakage.

Refilling pressurized gas containers in storage areas is not permitted.

For particularly hazardous gases such as chlorine and ammonia, additional safety measures must be taken.


Aerosols and compressed gas cartridges

Aerosols and compressed gas cartridges must not be warmed above 50 °C by exposure to sunlight or any other heat source. Therefore, the storage of such items in shop windows is not allowed.

7 SPECIAL STORAGE REQUIREMENTS FOR HAZARDOUS SUBSTANCES WITH SPECIFIC PROPERTIES

7.3 FLAMMABLE LIQUIDS

Vapours of flammable liquids and vapours can cause fires, deflagrations and explosions.

Labelling elements	Dangers
	<p>Liquids may be (extremely) flammable. Explosion.</p>

Special Measures:

It is mandatory to clarify, whether flammable liquids or vapours could be released and form explosive mixtures with air. When the risk of the release exists, explosion protection measures are always necessary.


NOTE: In chapter 6.8 the basic measures for explosion protection in the storage areas are shown. Further details on the comprehensive necessary measures can be taken from the ISSA brochures about explosion protection.

For all combustible liquids special attention has to be given to the retention facilities (Chapter 6.3) and fire fighting measures (chapter 6.6).

7.4 FLAMMABLE SOLIDS

Combustible (flammable) solids have a burning rate, which can range from slow glowing to rapid combustion. Dusts of

flammable solids can form explosive atmospheres when mixed with air and forming dust clouds.

Labelling elements	Dangers
	<p>Flammable solids</p>

Special Measures:

It is absolutely mandatory to clarify, whether dusts/powders of flammable or combustible solids may be released and

form explosive mixtures with air. Released powders and dust deposits must always be removed immediately.

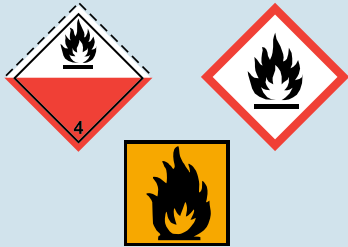
7 SPECIAL STORAGE REQUIREMENTS FOR HAZARDOUS SUBSTANCES WITH SPECIFIC PROPERTIES

7.5 PYROPHORIC SUBSTANCES

Pyrophoric substances react violently with oxygen. The reaction is so fast that they immediately catch fire when exposed to air.

SELF-HEATING SUBSTANCES

Self-heating substances are heated in contact with oxygen without external supply of energy, and they may ignite and catch fire after an extended period of time (hours or even days).

Labelling elements	Dangers
	<p>Catches fire spontaneously if exposed to air.</p> <p>Self-heating; may catch fire.</p>

Special Measures:

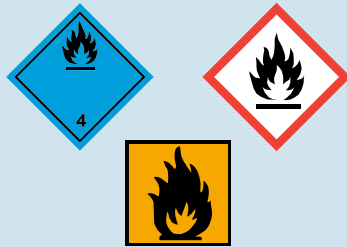
Pyrophoric substances must be stored at defined temperatures. The temperature of the stored goods must be controlled. Heating, for instance, by sunlight should be avoided. Therefore outdoor storage is not recommended.

Special Measures:

Self-heating substances must not be stored; if it is suspected that the packaging has been damaged during transportation. Due to their high fire risk, these chemicals should be stored separately (i.e. in a separate fire compartment) if possible, or together with non-flammable chemicals.

7.6 CHEMICALS, WHICH EMIT FLAMMABLE GASES TOGETHER WITH WATER

Some chemicals react violently with water, forming flammable gases, which can then be ignited.

Labelling elements	Dangers
	<p>In contact with water releases flammable gases which may ignite spontaneously.</p>

Special Measures:

The stored goods have to be protected from moisture. Particular care must be taken with fire protection measures. Suitable extinguishing agents have to be provided and a warning sign indicating this special hazard must be posted.

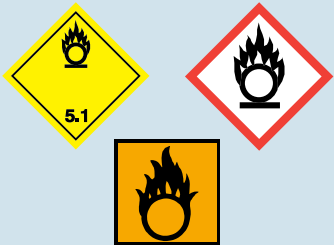
These chemicals are usually stored separately (in a separate fire compartment). To dissipate gases that are produced with atmospheric moisture/humidity, the storage room must be well ventilated.

7 SPECIAL STORAGE REQUIREMENTS FOR HAZARDOUS SUBSTANCES WITH SPECIFIC PROPERTIES

7.7 OXIDIZING SUBSTANCES

Oxidizing agents are chemicals that can support a fire without air supply. In a fire increase the burning rate and thus cause a fast spread of the fire. They may react

violently with other stored goods as well as with packaging material and trigger spontaneous fires.

Labelling elements	Dangers
	<p>(Strong) oxidizer May cause or intensify fire (or explosion)</p>

Special Measures:

Oxidizing agents (H272) may be stored only in certain conditions with flammable chemicals and materials such as packaging, pallets and fillers. These conditions must be taken from the safety data sheets and national regulations or they may result from a risk assessment. Spilled oxidising chemicals should not come in contact with combustible ma-

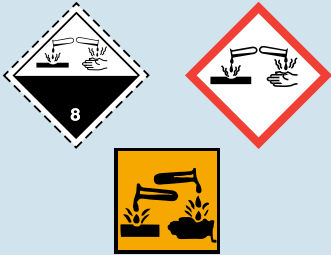
terials e.g. during clean-up). A safe removal is usually possible by dissolving oxidizers with plenty of water or with a suitable binder such as diatomaceous earth, sand or cement.

Strongly oxidizing chemicals (H271) must be stored separately in an own fire compartment.

7.8 CORROSIVE CHEMICALS

Dangerous/Hazardous substances with corrosive properties can damage the

skin, eyes and respiratory system and corrode metals.

Labelling elements	Dangers
	<p>Causes severe skin burns and eye damage. May cause respiratory irritation. May be corrosive to metals.</p>

Special Measures:

Among the corrosive chemicals are particularly acids and bases. These classes of substances react with each other, sometimes under intense heat release. Therefore they must be stored in separate areas. This may also be in the same fire compartment, if the mixing is prevented in the case of a leakage (for instance, by separate drip pans).

Due to the strong reactivity, the risks of a combined storage with other chemicals have to be considered with great care.

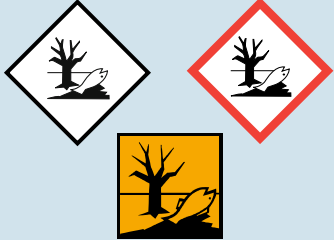
Drip pans must be made of acid-or alkaline resistant material.

For chemicals that generate highly irritating fumes, adequate ventilation has to be ensured.

7 SPECIAL STORAGE REQUIREMENTS FOR HAZARDOUS SUBSTANCES WITH SPECIFIC PROPERTIES

7.9 LIQUIDS WITH ENVIRONMENTAL DANGEROUS PROPERTIES

Some chemicals can have serious effects on environment when released.

Labelling elements	Dangers
	<p>Very toxic or harmful to aquatic life.</p>

Special Measures:

For the storage of water polluting chemicals often regional regulations must be taken into account.

During storage of these liquids, it is especially important that they cannot end-up in surface or underground water in case of a release. The retention facilities must be made of materials that are resistant to the chemicals stored.

Visit the Websites of the International Sections:

Agriculture: www.issa.int/prevention-agriculture

Chemistry: www.issa.int/prevention-chemistry

Construction: www.issa.int/prevention-construction

Education: www.issa.int/prevention-education

Electricity: www.issa.int/prevention-electricity

Health: www.issa.int/prevention-health

Information: www.issa.int/prevention-information

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