

Storage of Hazardous Materials

IAMC Toolkit

Innovative Approaches for the Sound Management of Chemicals and Chemical Waste



UNITED NATIONS
INDUSTRIAL DEVELOPMENT ORGANIZATION



Introduction

The presence of hazardous substances in a company involves special rules for handling, processing, disposal and storage of such substances. This presentation explains the rules to be applied when establishing storage systems.

The reader will learn about the use of the systems providing illustrations of technical solutions, general storage rules and specific rules for each storage category (including incompatibilities).

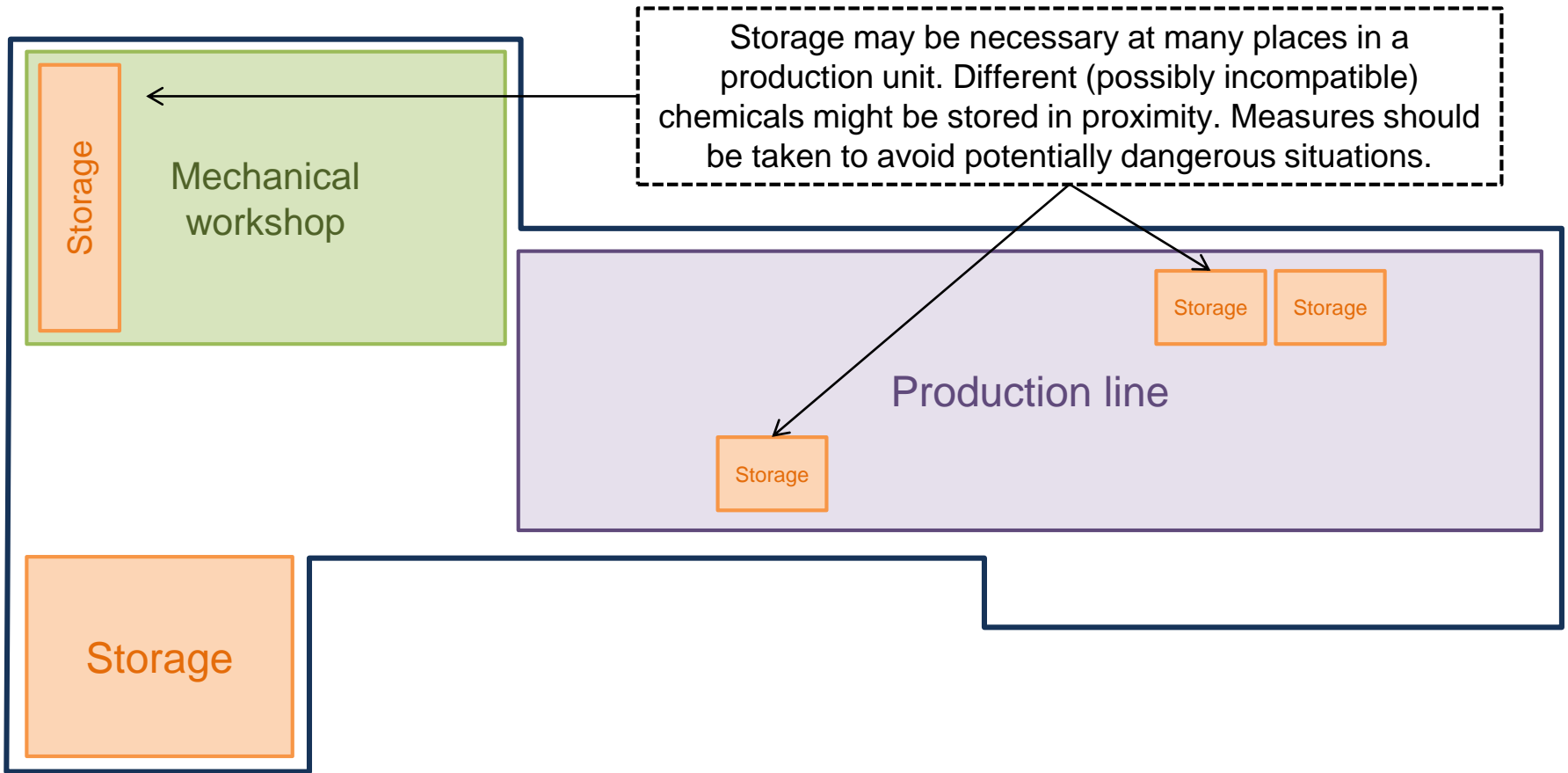
Hazard Management

1. Risk Identification and safety	2. Transport and storage	3. Fire and explosion protection	4. Emergency response
1.1 Chemical classification and labelling	2.1 Internal transport of chemicals	3.1 Fire protection	4.1 Emergency response plan
1.2 Risk assessment	2.2 Internal pedestrian routes	3.2 Fire protection in welding and cutting operations	
1.3 Safety rules	2.3 Storage	3.3 Explosion protection	
1.4 Personal protective equipment		3.4 Container cleaning	
1.5 Skin protection			
1.6 Emergency escape routes			
1.7 Solvents, acids, bases handling			
1.8 Safety in gas tank handling			

Contents

1. Introduction
2. Storage Concept
3. Technical Solutions
 - General storage rules
 - Specific rules for each storage category
 - Specific storage incompatibilities
4. Examples

Introduction – Storage Locations



Introduction

POTENTIAL DANGER	CONSEQUENCES
Fire/Explosion	Toxic vapours and gases Secondary reactions Water and soil pollution, due to contaminated fire-fighting water
Flooding	Environmental contamination due to polluted water
Leakages	Dispersion of toxic substances, harmful to the environment

Introduction

POTENTIAL DANGER	CONSEQUENCES
Acids + non precious metals	Spontaneous combustion (gaseous hydrogen)
Oxidants + organic materials (wood, paper, etc.)	Fire, explosion
Acids + bases	Exothermic reaction (heat emission + corrosive projections)
Nitric acid + organic substances or metals	Toxic nitrous gas
Chlorine bleach + acids	Toxic gaseous chlorine

Storage Concept

Storage Concept

The rules that guarantee the appropriate storage of hazardous materials are summarized in the storage concept, drawn up by the safety officer of a factory.

These rules are the same for large and small companies. Their application needs to be adapted to each situation, in a case-by-case approach.

Storage Concept

General objectives

1. **Matching** local conditions and measures to the hazards of stored products
2. **Identification** of conflicts and adjustment of storage
3. **Compliance** with legal requirements

Storage Concept

Contents of the storage concept

Description of the local environment

- Storage conditions
- Physical properties of storage room(s)
- Definitions of the stored substances

Hazardous substances

- Quantities
- Nature, hazards
- Identification on a map (storage and handling)

Measures

- Structural
- Technical
- Organizational

Storage Concept

Table of contents (example)

- Hazardous substances: overview of the dangers
- Identification of the storage place(s): map
- Receipt and storage
 - Storage rules
 - Illustrations
- Safety data sheets (SDSs)
- Inventory of hazardous substances
- Accidents
 - Spillage
 - Inhalation or contact with the skin or eyes
- Waste storage and disposal
- Organization: responsibilities and tasks
 - Training

Storage Concept

Organization: Tasks and responsibilities



Source : CSD / ISSPPRO

Technical Solutions

General Storage Rules: Containers

Original containers

- Hazardous substances must always be stored in their original containers.
- If they have to be poured into another container, the new receptacle must have the **same mechanical, chemical and physical properties** and must be **properly labelled**.

General Storage Rules: Identification of Hazardous Materials

Hazardous materials must be clearly identified.

Inventory and safety data sheets (SDSs)

The following data must be accessible:

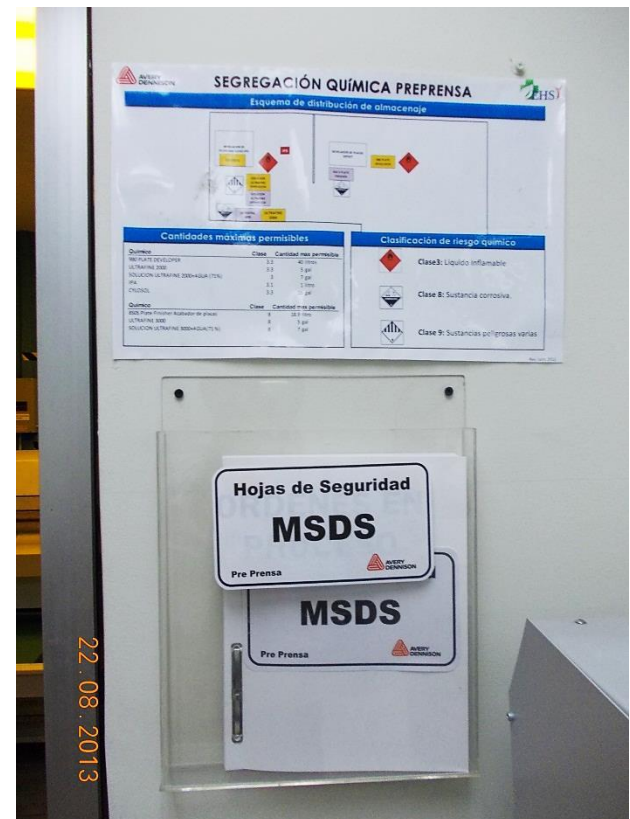
1. A register listing the maximum quantities for each category of hazardous material and the currently stored quantities
2. The storage position(s) on a map
3. A file containing the SDSs for every substance stored

General Storage Rules: Identification of Hazardous Materials

Inventory and safety data sheets (SDSs)



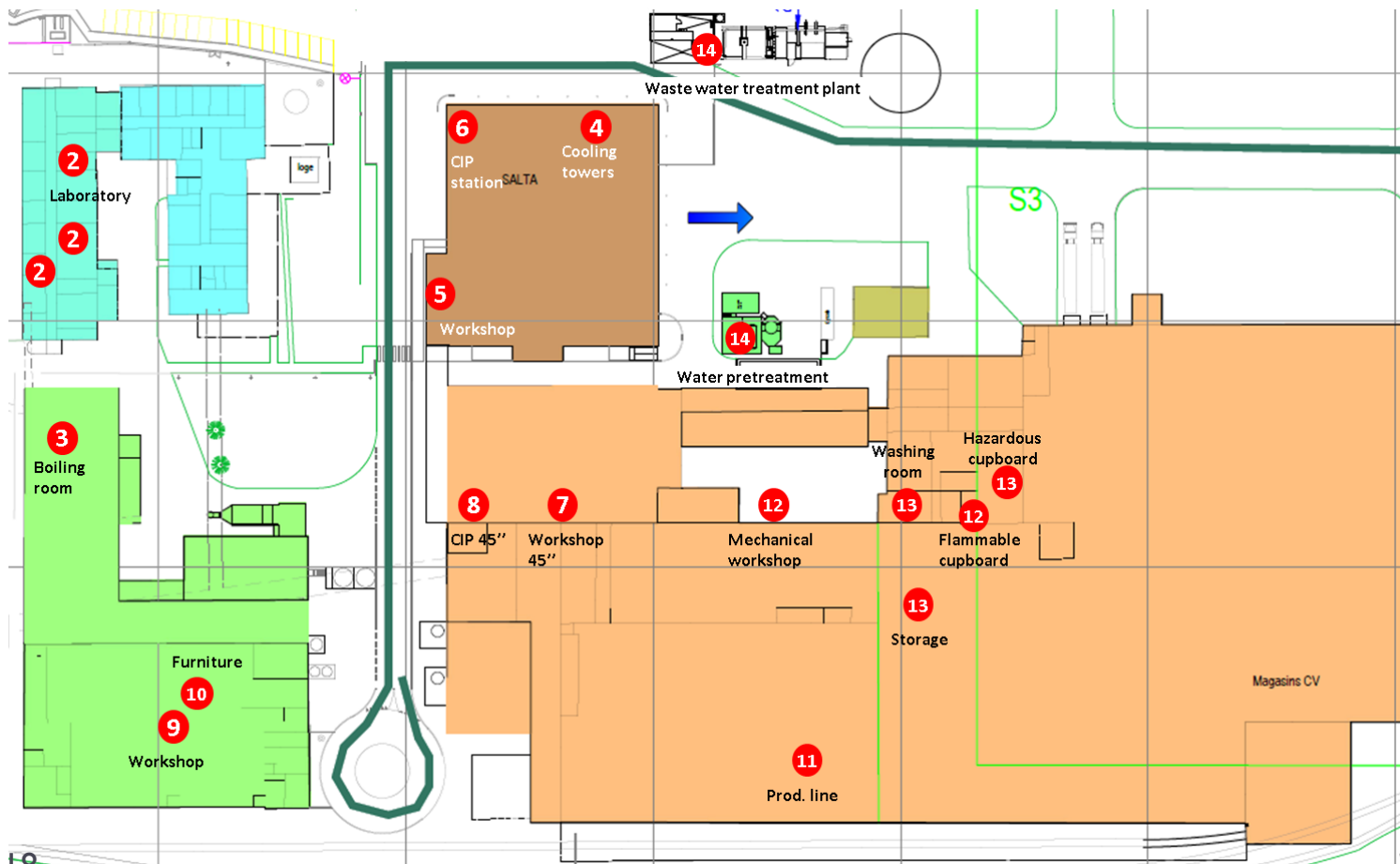
Source: CSD



Source: CSD

General Storage Rules: Identification of Hazardous Materials

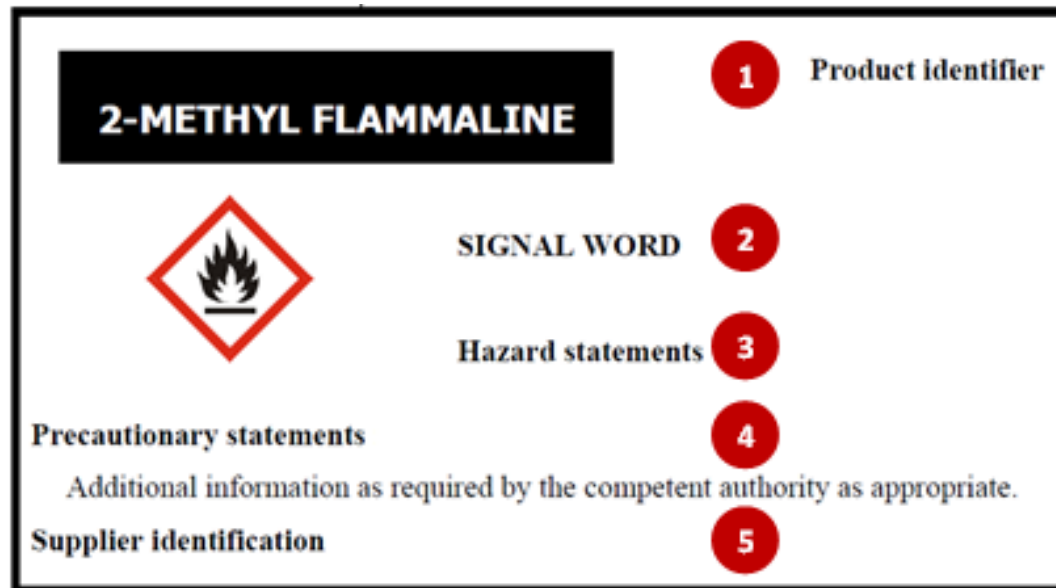
Identification of storage places (main and secondary)



General Storage Rules: Identification of Hazardous Materials

The containers must be labelled and the places where hazardous substances are stored must be marked.




Minimum information required on the labels:



Source: United Nations, Globally Harmonized System of Classification and Labelling of Chemicals (GHS)

General Storage Rules: Identification of Hazardous Materials

Label example

	Methanol (solvent) (N° CE: 603-001-00-X) 1	
	Highly flammable liquid and vapour	H225
	Toxic if swallowed Toxic in contact with skin Toxic if inhaled Causes damage to organs (especially to eyes)	3 H301 H311 H331 H370
	Keep away from heat, hot surfaces, sparks, open flames and other ignition sources. No smoking. Store in a well-ventilated place. Keep container tightly closed. Wear protective gloves/clothing, eye/face protection. If on skin: wash with water and soap. If swallowed: Rinse mouth. Do NOT induce vomiting. Immediately call a poison centre or a doctor. Store locked up.	4 P210 P403/233 P280 P302/352 P301/310 P405
2	Chemistry Example Sàrl St. Example 10, 1111 Town Telephone 032 600 60 60	5



















General Storage Rules: Excluding Storage Incompatibilities

What are storage incompatibilities?

- Certain chemical substances when **mixed together can trigger violent and potentially hazardous reactions**. Such substances are **incompatible** and must **not be stored together**.
- The compatibility matrices on the following slides show a classification of substances that, according to their hazardous properties, must not be **stored together (red)**, can **be stored together under certain conditions** that have to be verified in the SDS (**orange**) or can usually be **stored together without disadvantages (green)**.

General Storage Rules: Excluding Storage Incompatibilities

General incompatibilities

									
	○	-	-	-	-	-	+	-	-
	-	+	-	-	-	-	+	-	-
	-	-	+	○	-	-	-	-	-
	-	-	○	+	○	-	-	-	-
	-	-	-	○	○	○	○	○	○
	-	-	-	-	○	+	+	+	+
	+	+	-	-	○	+	+	+	+
	-	-	-	-	○	+	+	+	+
	-	-	-	-	○	+	+	+	+

Legend:



Can be stored together



Cannot be stored together



Can be stored together under certain conditions (check the SDSs)

Objective:

Avoid hazardous reactions

		Formic acid	Solution of ammonia	Solution of iron chloride (III)	Solution of iron chloride (III) sulfate	Acetic acid	Hydrofluoric acid	Solution of potassium hydroxide	Solution of sodium hydroxide	Solution of sodium hydrogensulfite	Solution of sodium hypochlorite	Peracetic acid	Phosphoric acid	Nitric acid	Hydrochloric acid	Sulphuric acid	Hydrogen peroxide
	Storage category	8	8	8	8	3	6.1	8	8	10/12	5	5	8	5	8	8	5
Formic acid	8	Grey	Yellow	Green	Green	Green	Green	Yellow	Yellow	Red	Red	Yellow	Green	Red	Green	Red	Red
Solution of ammonia	8	Yellow	Grey	Yellow	Yellow	Yellow	Yellow	Red	Red	Yellow	Yellow	Red	Yellow	Red	Yellow	Yellow	Yellow
Solution of iron chloride (III)	8	Green	Yellow	Grey	Green	Green	Green	Yellow	Yellow	Red	Red	Yellow	Green	Green	Green	Green	Yellow
Solution of iron chloride (III) sulfate	8	Green	Yellow	Green	Grey	Green	Green	Yellow	Yellow	Red	Red	Yellow	Green	Green	Green	Green	Yellow
Acetic acid	3	Green	Yellow	Green	Green	Grey	Green	Yellow	Yellow	Red	Red	Yellow	Green	Red	Green	Green	Red
Hydrofluoric acid	6.1	Green	Yellow	Green	Green	Green	Grey	Yellow	Yellow	Red	Red	Red	Green	Green	Green	Red	Green
Solution of potassium hydroxide	8	Yellow	Red	Yellow	Yellow	Yellow	Yellow	Grey	Green	Yellow	Green	Red	Yellow	Yellow	Yellow	Yellow	Yellow
Solution of sodium hydroxide	8	Yellow	Red	Yellow	Yellow	Yellow	Yellow	Green	Grey	Yellow	Green	Red	Yellow	Yellow	Yellow	Yellow	Yellow
Solution of sodium hydrogensulfite	10/12	Red	Yellow	Red	Red	Red	Red	Yellow	Yellow	Grey	Red	Red	Red	Red	Red	Red	Yellow
Solution of sodium hypochlorite	5	Red	Yellow	Red	Red	Red	Red	Green	Green	Red	Grey	Red	Red	Red	Red	Red	Yellow
Peracetic acid	5	Yellow	Red	Yellow	Yellow	Yellow	Red	Red	Red	Red	Red	Grey	Red	Red	Red	Red	Red
Phosphoric acid	8	Green	Yellow	Green	Green	Green	Green	Yellow	Yellow	Red	Red	Red	Grey	Green	Green	Green	Green
Nitric acid	5	Red	Red	Green	Green	Red	Green	Yellow	Yellow	Red	Red	Red	Green	Grey	Red	Red	Red
Hydrochloric acid	8	Green	Yellow	Green	Green	Green	Green	Yellow	Yellow	Red	Red	Red	Green	Red	Grey	Red	Green
Sulphuric acid	8	Red	Yellow	Green	Green	Green	Red	Yellow	Yellow	Red	Red	Red	Green	Red	Red	Grey	Green
Hydrogen peroxide	5	Red	Yellow	Yellow	Yellow	Red	Green	Yellow	Yellow	Yellow	Yellow	Red	Green	Red	Green	Green	Grey

Source: Based on Sicherheitsinstitut

General Storage Rules: Leakages Must Be Confined

Overflows, leakages, accidental spillage, etc. may occur.



Hazardous liquid substances must be stored on a **catch basin.**

Objectives:

- Prevent human exposure and environmental contamination
- Prevent the mixing of substances and hazardous reactions

General Storage Rules: Leakages Must Be Confined

Catch basins: Examples

From the smallest quantities to the largest



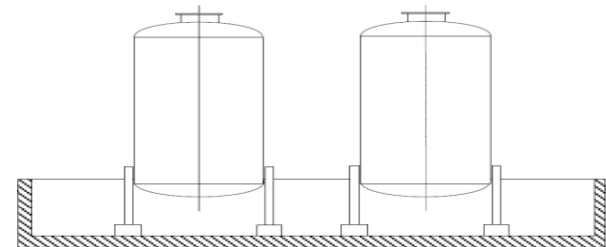
Source: CSD

Post-storage



Source: UNIDO

Container storage



Source: ECA

Bulk storage

General Storage Rules: Leakages Must Be Confined

Catch basins: Design

- The retention capacity must provide for at least 100% of the highest volume stored.
- The material must be adapted to the substances stored (e.g. concrete is not suitable for solvent retention).

General Storage Rules

Other general rules

1. The **flooring of the storage area must be impermeable**. A special coating (sealing) will often be necessary, as concrete is permeable to many substances. This coating must be incombustible. **Structural**
2. The separation of the storage areas (or compartments) according to the **storage categories must be clearly identified** and labelled (flammable, toxic, corrosive, etc.). **Good practice**
3. Other non-hazardous **materials should not be stored in the same place** (wrapping, paper, cardboard, spare parts, etc.). **Good practice**
4. The containers must be **protected from any mechanical or thermal influence** (heat sources, object falls, pressure through weight, etc.). **Good practice**

General Storage Rules

5. There must be **one responsible person** (and one substitute) appointed for the storage area(s). **Organizational**
6. Appropriate **personal protective equipment** (PPE) must be easily available and properly maintained. **Organizational**
7. At least one **eye shower** must be installed. An emergency shower can be necessary. **Organizational**
8. Store minimum quantities. **Good practice**
9. Control stock, i.e. first-in/first-out, move redundant stock. **Good practice**
10. Segregate “empties” (cylinders, sacks, drums, bottles). **Good practice**
11. Ensure adequate access for both normal and emergency purposes with alternative routes. **Structural/Good practice**

General Storage Rules

12. Monitor stock, (temperature, pressure, degradation of substances, deterioration of packaging or containers/corrosion, leakages, condition of labels, expiry date, etc.) **Good practice**
13. Decontamination and first-aid provisions (neutralize/destroy, fire-fighting). **Technical**
14. Appropriate gas/vapour/fume/pressure venting must be available (e.g. flame arrestors, scrubbers, absorbers, stacks). **Technical**
15. Provide adequate, safe lighting. **Technical**
16. Limit stack heights. Generally chemicals should be stored off the ground (e.g. to facilitate cleaning, to keep above any ingress of water in the event of flooding).

Source: Hazardous Chemicals Handbook



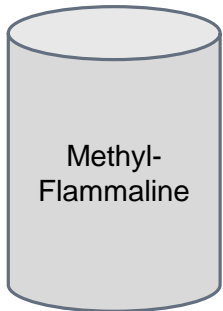
General Storage Rules – Exercise


Cite the four main storage rules and give examples of measures.




















General Storage Rules – Exercise

Four main storage rules



2-METHYL FLAMMALINE		1 Product identifier
	SIGNAL WORD	2
	Hazard statements	3
Precautionary statements		4
Additional information as required by the competent authority as appropriate.		
Supplier identification		5

								
	○	-	-	-	-	-	+	-
	-	+	-	-	-	-	+	-
	-	-	+	○	-	-	-	-
	-	-	○	+	○	-	-	-
	-	-	-	○	○	○	○	○
	-	-	-	-	○	+	+	+
	+	+	-	-	○	+	+	+
	-	-	-	-	○	+	+	+
	-	-	-	-	○	+	+	+

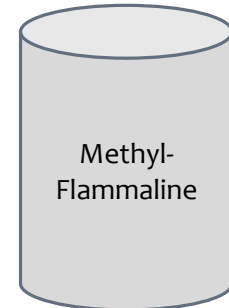


General Storage Rules – Exercise

Four main storage rules

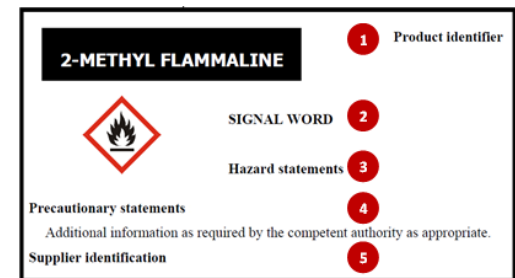
1. Original container

- Hazardous substances must always be stored in their original containers.
- If they have to be poured into another container, the new receptacle must have the **same mechanical, chemical and physical properties** and must be **properly labelled**.



2. Hazardous material must be clearly identified

- The following information should be available:
 - A register including the maximum quantities for each category of hazardous material and the currently stored quantities
 - The storage position(s) on a map
 - A file containing the SDSs for every substance stored



Source: United Nations

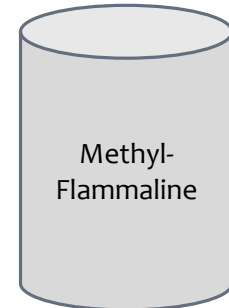


General Storage Rules – Exercise

Four main storage rules

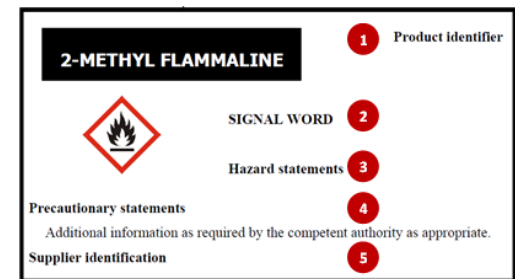
1. Original container

- Hazardous substances must always be stored in their original containers.
- If they have to be poured into another container, the new receptacle must have the **same mechanical, chemical and physical properties** and must be **properly labelled**.



2. Hazardous material must be clearly identified

- The following information should be available:
 - A register including the maximum quantities for each category of hazardous material and the currently stored quantities
 - The storage position(s) on a map
 - A file containing the SDSs for every substance stored



Source: United Nations



General Storage Rules – Exercise

Four main storage rules

3. Exclude storage incompatibilities

- Hazardous substances must be stored separately from any other non-hazardous material, and especially from food or drugs.
- Acids and bases must not be stored together.

	○	-	-	-	-	-	+	-	-
	-	+	-	-	-	-	+	-	-
	-	-	+	○	-	-	-	-	-
	-	-	○	+	○	-	-	-	-
	-	-	-	○	○	○	○	○	○
	-	-	-	-	○	+	+	+	+
	+	+	-	-	○	+	+	+	+
	-	-	-	-	○	+	+	+	+
	-	-	-	-	○	+	+	+	+

Source: Based on Neosys

4. Leakages must be confined

Hazardous liquids must be stored on a catch basin in order to manage overflow, leakage or accidental spillage. The objective of containing the liquid and avoiding its dispersion is to prevent:



























- Environmental contamination and human exposure
- One of the hazardous reactions previously mentioned



Source: United Nations



Specific Storage Rules – Categories

Storage class	Substances property	ADR/UN labeling	GHS labelling
SC 2	Liquefied or under pressure gas	  	 
SC 3	Flammable liquid		
SC 4.1	Flammable solid		
SC 4.2	Auto flammable		
SC 4.3	Contact with water produces flammable gas emissions		
SC 5	Oxidizing substances / organic peroxides	 	 
SC 6.1	Toxic		 
SC 8	Corrosive or caustic		
SC 9	Other hazardous substances, incl. environmentally hazardous	 	 

Source: United Nations

Specific Storage Rules – Categories

N°	Storage category
2	Gases: compressed liquefied or dissolved under pressure
3	Flammable liquids
4.1	Flammable solids
4.2	Pyrophoric substances
4.3	Water reactive substances (substances which in contact with water emit flammable gases)
5	Oxidizing substances and organic peroxides
6	Toxic substances
8	Corrosive and caustic substances



Specific Storage Rules – Category 2

Storage Category 2: Liquefied gases or gases under pressure

SPECIFIC DANGERS

- Gas leakage
- In case of accidental destruction or fire, the pressurized container can turn into a dangerous projectile.



Source: Suva

- Gas bottles must be protected by a fence.
- Use natural or forced ventilation:
 - Extraction near the ceiling if the gas is lighter than the air
 - Extraction near the floor if the gas is denser than the air
 - Air renewal 3 to 5 times per hour
- Ammoniac and gaseous chlorine require specific storage conditions, designed by a specialist (service provider).



Specific Storage Rules – Category 3

Storage Category 3: Flammable liquids

SPECIFIC DANGERS

- Flammability of the substance
- Potentially explosive vapours

- Keep away from ignition sources.
- Electrical devices in storage rooms must be grounded and used so as to avoid ignition.
- Empty containers must be carefully cleaned as explosive air/gas mixes might develop.
- Smoking is forbidden and appropriate prohibitive signs are displayed.
- Containers must always be closed to avoid evaporation.



Source: Suva

Specific Storage Rules – Category 3

Danger classes	Description	Examples
F1	Liquids with a maximum flash point of 21°C	Gasoline, acetone, cellulose thinner
F2	Liquids with a flashpoint higher than 21°C and lower than 55°C	Petroleum, mineral oil
F3	Liquids with a flashpoint higher than 55°C and lower than 100°C	Extra-light heating oil, diesel
F4	Liquids with a flashpoint higher than 100°C	Lubricating oils, vegetable oils
F5	Liquids with low flammability	Halogenated hydrocarbons
F6	Incombustible liquids	Water

Source: Based on VKF/AEAI



Specific Storage Rules – Category 3

Flammable liquids: Categories and quantities

	Maximum authorized quantity [l]	
Storage place (small container/tank)	Categories F1 and F2	Categories F3, F4 and F5
Any type of room	max. 5	max. 30
Cupboard made of hardly flammable materials	max. 100	max. 450
Premises with specific structural properties designed to resist fire	> 100	> 450

Source: Based on VKF/AEAI

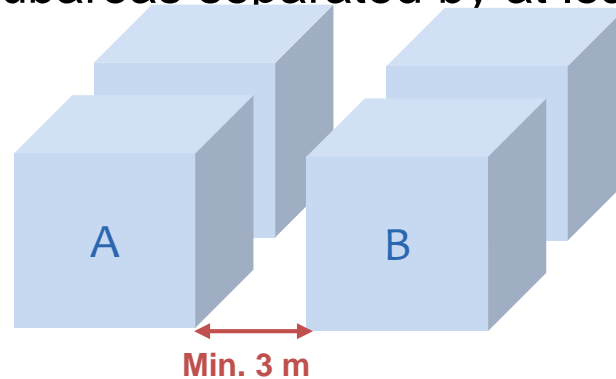
Specific Storage Rules – Category 3

Flammable liquids: Large quantities

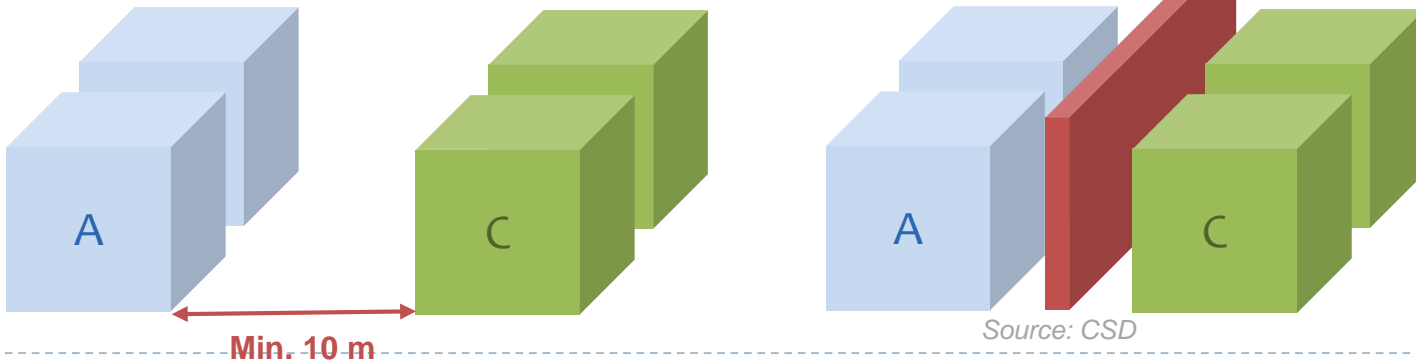
Quantity	Structural requirements
>100 litres (F1, F2) >450 litres (F3, F4, F5)	Flammable liquids can be stored together in a specific room built from material with a fire resistance period of 30 minutes and fire compartments.
>1,000 litres	Each substance must be isolated in a specific fire compartment.
>2,000 litres	Protection against lightning is mandatory.

Specific Storage Rules – Category 3

- For compatible substances (A and B), storage compartments should be divided into storage subareas separated by at least **3 metres**.



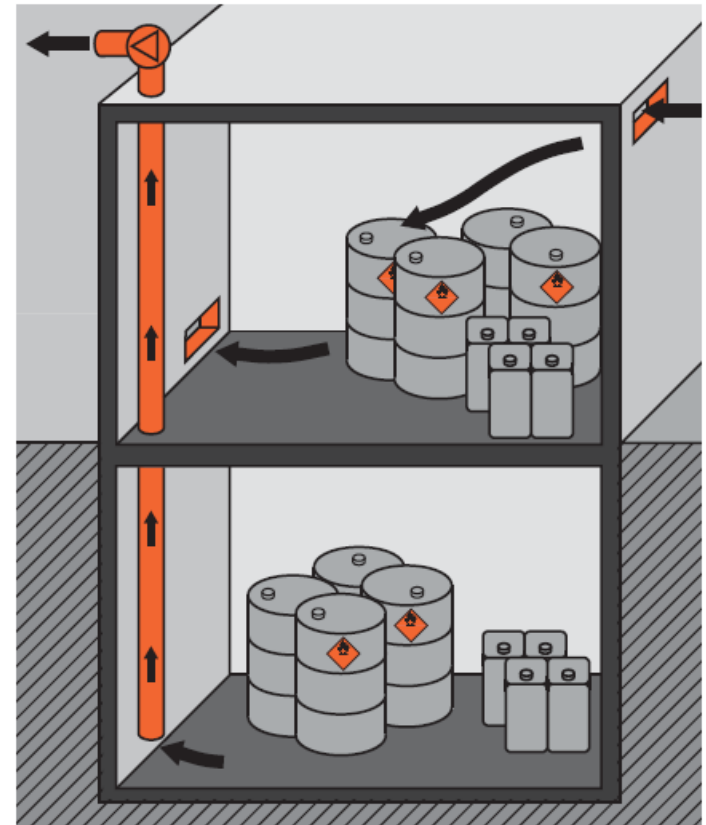
- For incompatible substances (A and C), storage compartments should be separated by at least **10 metres** or by a **firewall**.



Specific Storage Rules – Category 3

Storage rooms must be properly ventilated

- **Natural ventilation** is sufficient if:
 - The room has two openings directly connected to the ambient air.
 - One opening is placed at a maximum height of 10 cm above the ground.
 - Each opening requires at least 20 cm² per square metre of floor area.
- **Forced ventilation:** Air extractors might be needed to **renew the air 3 to 5 times per hour**.
 - Extraction from the upper or lower part of the premises is chosen according to the gas property.
 - The opening must be placed at a maximum height of 10 cm above the ground.



Source: Suva

Specific Storage Rules – Category 3

Storage rooms must be properly ventilated

- Forced ventilation is mandatory in large warehouses where liquids are stored in stacks on pallets.
- The air replacement frequency (3 to 5 air exchanges per hour) is calculated based on 3 metres elevation.



Source: ECA

Specific Storage Rules – Category 3

Outdoor storage

- Drums containing **flammable liquids** are preferably **stored outdoors**, so that any flammable vapour can readily disperse. Similar considerations may apply to the dispersion of vapours and fumes from drums containing toxic liquids or solids. In some cases, weather protection is provided by a roof.
- The next slide provides recommendations on outdoor storage from the *Hazardous Chemicals Handbook*, including safety distances to neighbouring buildings.
- As a comparison, the Swiss procedure for the evaluation of safety distances is presented on the next slide but one.

Specific Storage Rules – Category 3

Outdoor storage: International recommendations

- Label each drum and affix appropriate warnings (e.g. “Highly Flammable”).
- Limit stack heights, e.g. 4.5 m for 200 litre drums, 5 m for drums stored on end and 4 m on pallets.
- Segregate **highly flammable liquids** and mark the stacks. Classify the area as Zone 2. Place material >15 m away from any working building, facility building or plant and 7.5 m from plant boundaries and boundary fences.
- Place **stacks of combustible material** >7.5 m away from buildings and 4 m from plant boundary fences.
- Restrict the number of 180 litre drums to 1,500.
- Provide >5 m clearance between adjacent stacks with access on three sides for fire fighting.

Specific Storage Rules – Category 3

(Swiss Procedure)

Outdoor storage

Buried or unburied tanks, stored outside a building or installation

- Access must be limited to authorized persons (a fence is mandatory, surveillance might be needed).
- A safety distance to neighbouring buildings must be observed, depending on the **category**, the **volume** of liquids and the **risks for the neighbourhood**.



Source: Based on ECA

Specific Storage Rules – Category 3

(Swiss Procedure)

Outdoor storage: Evaluation of the neighbourhood risk

Neighbouring building – Type	Neighbouring building – Activity		
	Low danger (Production, treatment and storage of non-flammable material)	Medium danger (Engineering workshops, car repair, offices, apartments)	High danger (Storage/Treatment of hazardous materials, wood processing, printing, buildings with many occupants)
Specifically resistant to fire	Low	Low	Low
Non-flammable (concrete)	Low	Medium	High
Flammable (wood)	Medium	High	High

Specific Storage Rules – Category 3

(Swiss Procedure)

Outdoor storage: Safety distance for storage in **containers**

[Metres]	Categories F1 and F2			Categories F3, F4 and F5		
Risk evaluation: Neighbouring building	<5,000 l	5,000-50,000 l	>50,000 l	<5,000 l	5,000-50,000 l	>50,000 l
Low	5	10	15	-	5	8
Medium	10	15	20	5	8	12
High	15	20	25	8	12	15



Specific Storage Rules – Category 3

(Swiss Procedure)

Outdoor storage: Safety distance for storage in **tanks**

[Metres]	Categories F1 and F2			Categories F3, F4 and F5		
Risk evaluation: Neighbouring building	Overpressure resistant tank	<500 m ³	>500 m ³	Overpressure resistant tank	<500 m ³	>500 m ³
Low	12	20	30	6	10	15
Medium	16	25	35	8	12	18
High	20	30	40	10	15	20



Specific Storage Rules: Flammable Liquids – Exercise

What are the **main dangers** related to flammable substances?

Provide **four** storage measures.

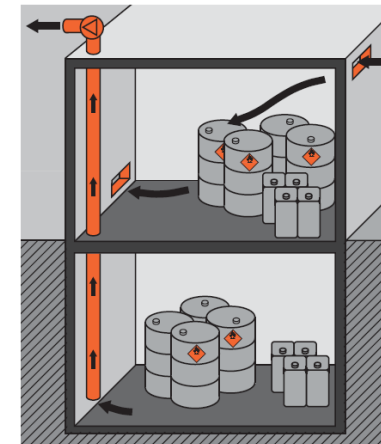
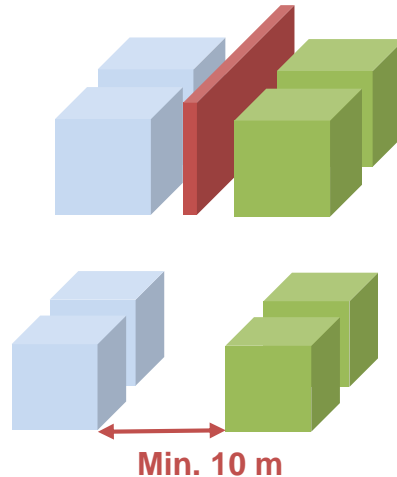


Specific Storage Rules: Flammable Liquids – Exercise

- Main dangers:
 - Flammability of the substance
 - Potentially explosive vapours
- Storage measures:



Source: Suva



Source: SUVA

Specific Storage Rules – Category 4.1

Storage Category 4.1: Flammable solids

SPECIFIC DANGERS

- Fire can smoulder for days or weeks, unnoticed, before actual flames are visible.
- Consider that even non-flammable solids can be explosive (dust or flour).



Source: Shutterstock

- Dust deposits must be avoided and regularly cleaned.
- Proximity to ignition sources must be avoided.
- For quantities over 1,000 kg, the substances must be isolated in a fire compartment.

Specific Storage Rules – Category 4.2

Storage Category 4.2: Pyrophoric (auto-flammable) substances

SPECIFIC DANGERS

- Can ignite very fast when in contact with the air, even in very low quantities
 - Examples: phosphor, freshly prepared metallic powders
-
- Must never be stored outdoors
 - Must be protected from any heat source, the ambient temperature should be controlled
 - **Must not be stored with combustible, explosive or flammable substances**
 - For quantities over 1,000 kg, the substances must be isolated in a fire compartment.

Specific Storage Rules – Category 4.3

Storage Category 4.3: Water reactive substances

SPECIFIC DANGERS

- Substances which in contact with water emit flammable gases that can ignite spontaneously
 - Examples: calcium, zinc powder
-
- Must be stored in a dry place in hermetically closed containers
 - **Must not be stored with halogens (fluorine, chlorine, bromine)**
 - For quantities over 100 kg, the substances must be isolated in a fire compartment.
 - Specific extinguishers must be available and the sign “Do not extinguish with water” must be visible.



Specific Storage Rules – Category 5

Storage Category 5: Oxidizing substances/organic peroxides

SPECIFIC DANGERS

- Create highly flammable or explosive mixes with any combustible material, flammable substance or just paper, sugar or wood
 - Examples: ferric nitrate, hydrogen peroxide, lead perchlorate
-
- **Must not be stored with combustibles (even non-hazardous substances, wood or paper) or caustic substances**
 - Small quantities (less than 100 kg), can be stored in the same room as other substances, but in a separate specific metal box or cupboard. Some organic peroxides must be refrigerated.
 - For quantities over 100 kg, the substances must be isolated in a fire compartment.

Specific Storage Rules – Category 6.1

Storage Category 6.1: Toxic substances

SPECIFIC DANGERS

- Can be very harmful, even fatal, in very small quantities

- **The storage premises must be secured and only accessible to authorized persons (key or code).**
- For quantities over 1,000 kg, the substances must be isolated in a fire compartment.

Specific Storage Rules – Category 8

Storage Category 8: Corrosive and caustic substances

SPECIFIC DANGERS

- Can be very harmful, even fatal, in case of contact with the skin, the eyes or in case of ingestion or inhalation of vapours
- **Must not be stored with substances that create toxic gases with acids or with combustive and oxidizing substances**
- Containers and catch basins must be resistant to corrosion (special plastics or resin).
- Acids and bases must be physically separated and stored on distinct catch basins.
- For quantities over 1,000 kg, the substance must be isolated in a fire compartment.



Storage of Hazardous Waste

The same rules apply!

Store hazardous waste in the same way you would store the substance.

- ⇒ Adequate labelling
- ⇒ Suitable storage premises
- ⇒ Proper storage conditions
- ⇒ ...

In Case of an Accident

Accident	Reaction	Required material
Spillage and leakage	Cover the liquid with absorbent material. The absorbent material used must be treated as hazardous waste. Confine the liquid. Evacuate the area.	Absorbent material (e.g. sand) Physical barriers
Contact with eye or skin	Rinse abundantly. Contact medical assistance.	Eye wash facility, shower (at least direct access to water) Phone
Inhalation	Breathe fresh air and contact medical assistance.	Phone
Onset of fire	Extinguish if possible. Contact rescue services.	Fire blanket, extinguisher (specific to the chemicals stored)

Examples



What Is Correct, What Is Not?



- Acid storage and transfer to operation area

- Correct:
 - Appropriate tank in terms of material and stability
- Wrong:
 - No label, no hazard warning
 - No catch basin

What Is Correct, What Is Not?



- Hydrochloric acid stored in five 200-litre containers

- Correct:

- Appropriate containers in terms of material and stability

- Wrong:

- Direct sun
- No catch basin
- Danger is not clearly indicated

What Is Correct, What Is Not?



Source: CSD

- Paint and flammable substances stored in a metal cupboard in an operation area

- Correct:
 - The place of each substance is labelled.
 - The cupboard is made of non-flammable material (metal).
- Wrong:
 - The labels are not standard labels (some information is missing).
 - Some containers do not have any label.
- To be checked:
 - Retention capacity might not be sufficient.

Additional Information

- Hazardous substances are stored in different ways, usually on racks or in stacks. As long as the storage premises are small, the type of storage has no critical impact in case of a fire or a major accident.
- However, the larger the quantities stored, the greater influence the type of storage premises will have on the fire (accident) event.
- The type of storage has a direct influence on the safety measures to implement.

Additional Information - Storage Rooms

Type of storage	Main dangers	Measures
High-rack storage	<ul style="list-style-type: none"> - Very high influence of the packaging (wooden pallets, cardboard, plastic films) - Storage location not always easily accessible - Stack effect which can lead to the rapid propagation of a fire 	<ul style="list-style-type: none"> - When the storage height exceeds 7.5 m, the rules should be stricter (extinguishing installations might be required).
Stacked storage	<ul style="list-style-type: none"> - Origin of the fire often inaccessible - Collapse 	<ul style="list-style-type: none"> - Limit the partial storage areas to 100 m². - Impose minimum distances of 2.5 m between stacks. - Limit the width per stack to a maximum of four pallets. - Limit the height per stack to 5 or 6 m.
Bottle storage	<ul style="list-style-type: none"> - Bursting of pressure vessels (especially in case of an increase in temperature) - Propagation of the fire by bottle or aerosol bombs projected in the air - Propagation of gases 	<ul style="list-style-type: none"> - Store outdoors or in a fire compartment. - Implement ventilation measures. - If necessary, install a gas detector. - If necessary, provide extinguishing installations - Protect against explosions.
Storage at very low temperatures	<ul style="list-style-type: none"> - Frostbites - Asphyxiation - Gas propagation - Explosion - Hypothermia 	<ul style="list-style-type: none"> - Temperature monitoring - Storage in a fire compartment - Ventilation measures - Protection against explosions - If necessary, install a gas alarm unit



Key messages

A Storage Concept aims at :

- Matching local conditions and measures to the hazards of stored products
- Identifying conflicts and adjustment of storage
- Complying with legal requirements

Technical Solutions should be applied to adequately manage storage rules. Specific rules for each storage category should be established.



Sources

Sources

- CSD Engineers, Switzerland/ISSPPRO, Germany, 2015
- Vereinigung Kantonaler Feuerversicherungen: Directive de protection incendie, liquides inflammables, 2003 (<http://www.vkf.ch>) (Switzerland)
- United Nations: Globally Harmonized System of Classification and Labelling of Chemicals (GHS), 2003, last revision 2013
- Carson, P., Mumford, C.: Hazardous Chemicals Handbook (Second Edition), 2002
- United Nations: UN Recommendations on the Transport of Dangerous Goods, last revision 2013

Sources

- FOEN: Guide «Entreposage des matières dangereuses», Switzerland, 2011
- VKF/AEAI: Directive protection incendie, liquides inflammables, Switzerland, 2003
- VKF/AEAI: Distances de sécurité, compartiments coupe-feu, Switzerland, 2003
- Suva: Liste de contrôle – Stockage de liquides facilement inflammables, Switzerland, 2011
- Sicherheitsinstitut: Lagerung gefährlicher Stoffe, Leitfaden für die Praxis, Überarbeitete Auflage 2011, Switzerland, 2011
- Neosys: Formation matières dangereuses, Switzerland, 2011

Images

- CSD Engineers, Switzerland, 2015
- United Nations Industrial Development Organization (UNIDO), 2015
- United Nations: Globally Harmonized System of Classification and Labelling of Chemicals (GHS), 2003, last revision 2013
- FOEN: Guide «Entreposage des matières dangereuses», Switzerland, 2011
- Suva: Liste de contrôle – Stockage de liquides facilement inflammables, Switzerland, 2011

Images

- ECA: Incendie et éléments naturels: Distances de sécurité. Cours spécialiste en protection incendie AEAI, Switzerland, 2011
- ECA Incendie et éléments naturels: Installations sprinklers, Switzerland, 2008
- Suva: Santé et sécurité au travail lors de l'emploi de solvants, Switzerland, 2012
- Suva: Bouteilles à gaz – Entrepôts, rampes, systèmes de distribution de gaz, Switzerland, 2007
- Shutterstock, USA, 2015

Disclaimer

This presentation was prepared with the requested diligence and with the generally accepted principles of the relevant field.

If a third party uses the contents of the presentation in order to take decisions, the authors disclaim any liability for any kind of direct or indirect (consequential) damage.

The copyrights to all text, images, logos, photographs, and all other information contained in the presentation belong to UNIDO.

