General Admin. of Civil Defence
Prevention Department
Inspection & Permits Section

GUIDELINES FOR SAFE CHEMICAL STORAGE

Good Practice, Safe Storage and Handling of Packaged Hazardous Chemicals

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FOREWORD

In line with the wise directives of our leadership, particularly in the scientific field, and recognizing scientific development's role as one of the most critical components of human advancement and the progression of human civilization, It gives me great pleasure to present this “Guideline for Good Practice, Safe Storage, and Handling of Packaged Hazardous Chemicals” to serve as a comprehensive manual for small and medium-sized enterprises and a guide for every learner in this field. I hope it serves as a resource for a generation that understands and appreciates the importance of scientific research and academic achievement, contributing to the highest standards of national security and safety.

Storing and handling hazardous materials safely is crucial in many industries and sectors, whether commercial, industrial or even in public places as these materials may be dangerous to human health and the environment if they are not handled with caution and good practices.

This guideline aims to provide practical instructions for individuals and institutions dealing with hazardous materials. It covers the fundamental principles of safely storing hazardous materials, including selecting the appropriate storage location, designing and organizing storage spaces, and using warning labels and safety instructions.

It also provides guidance on handling hazardous materials properly, including the procedures to be followed when dealing with these materials and the necessary preventive measures to reduce risks and avoid accidents, thereby improving workplace safety and minimizing risks to the human health and the environment..

PREFACE

Handling and storing hazardous materials safely is essential in a wide range of industries and environments, whether industrial or commercial. These materials are a source of concern due to their high risk to the human health and the environment, which necessitating the need for a comprehensive guide to safety practices and proper handling.

Storing hazardous materials requires careful strategies and strict procedures to ensure personal and environmental safety. By understanding the details of safe storage and proper handling, organizations and individuals can reduce the risks of accidents and pollution and ensure compliance with health and environmental regulations and standards.

This guidelines manual aims to provide practical strategies and valuable advice for those dealing with hazardous materials, whether in a work environment or in their personal surroundings. The manual covers the fundamental principles of safe storage and proper handling of hazardous materials, as well as reviewing modern tools and techniques that help to improve safety and reduce risks.

By reading this guidelines and applying the principles and guidelines it offers, individuals and institutions can be better prepared to handle hazardous materials safely and confidently, thereby reducing risks and enhancing safety in the work environment.

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Definitions

Chemical substance: A substance composed of an element, or a compound formed when elements are chemically bonded.

Classification of chemical and hazardous substances for storage: means classification of chemical and hazardous substances by their physical, chemical properties or their possible hazards for purposes of safety storage.

Firewalls: means the vertical partitions built to separate the internal and external areas of the building and prevent the spread of fire, which are constructed of fire-resistant materials that can withstand fire. The fire-resistant ratings are, depending on types of materials and thickness of walls such as, 30 minutes, 60 minutes, 120 minutes etc. in compliance to Qatar Civil Defence Department (QCDD) regulations.

Fire-Resistant Materials: Construction materials that withstand combustion for a determined interval of time.

Hazardous Substance: any substance whether solid, liquid, or gas that may cause harm to health, Safety and Environment.

Packaging means packages and International Bulk Containers (IBCs) used to contain chemical or hazardous substance for storage in the storage facility.

Preventive measures means measures taken to prevent any dangers that may occur from chemical and hazardous substances storage.

Safety signs means specific signs and symbols identifying activities, situations and providing information or operational procedures related to safety and/or occupational health, with which colors and symbols are coordinated and entitled to be in compliance to concerned laws.

Special Measures means additional requirements for a storage facility of chemical and hazardous substances of specific properties.

Storage Facility means an area used to store chemical and hazardous substances.

Containers: Receptacles or vessels designed to hold and transport various items, substances, or materials.

Storage : Storage of chemical and hazardous substances inside and outside a storage facility.

Control area: Abuilding or portion of a building or outdoor area within which hazardous materials area allowed to be stored, dispensed, used, or handled in quantities not exceeding the Maximum allowable quantity (MAQ)

Approved: measn it meets the requirements of Qatar civil defense in security and safety.

INTRODUCTION

INTRODUCTION

How chemicals are safely stored?

This question is relevant not only in chemical plants but also in companies and establishments where chemical storage and handling are the essential means for their operations.

Samples of these chemicals include:

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

To give light on businesses operating on this scale, this guidelines aims to provide useful and essential information to where and how chemicals should be kept, especially for small and medium-sized businesses.

Within these guidelines, requirements for the safe storage and handling of chemicals are explained. Specifically, the requirements for hazardous substances with specific properties are summarized in Chapter 7.

SCOPE & OBJECTIVES

The scope of these guidelines is to established awareness of the safe storage and handling of chemicals, particularly hazardous substances.

The states of Hazardous substances can be:

- Liquids
- Gases
- Solids

These materials can be packaged as pure chemical substances or as mixtures due to their:

- Physical and chemical properties
- Danger to health
- Threat to the environment

Usually, hazardous materials are recognized by their hazard symbols or pictograms - an overview of possible hazardous material labels is shown in Figure 1.

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

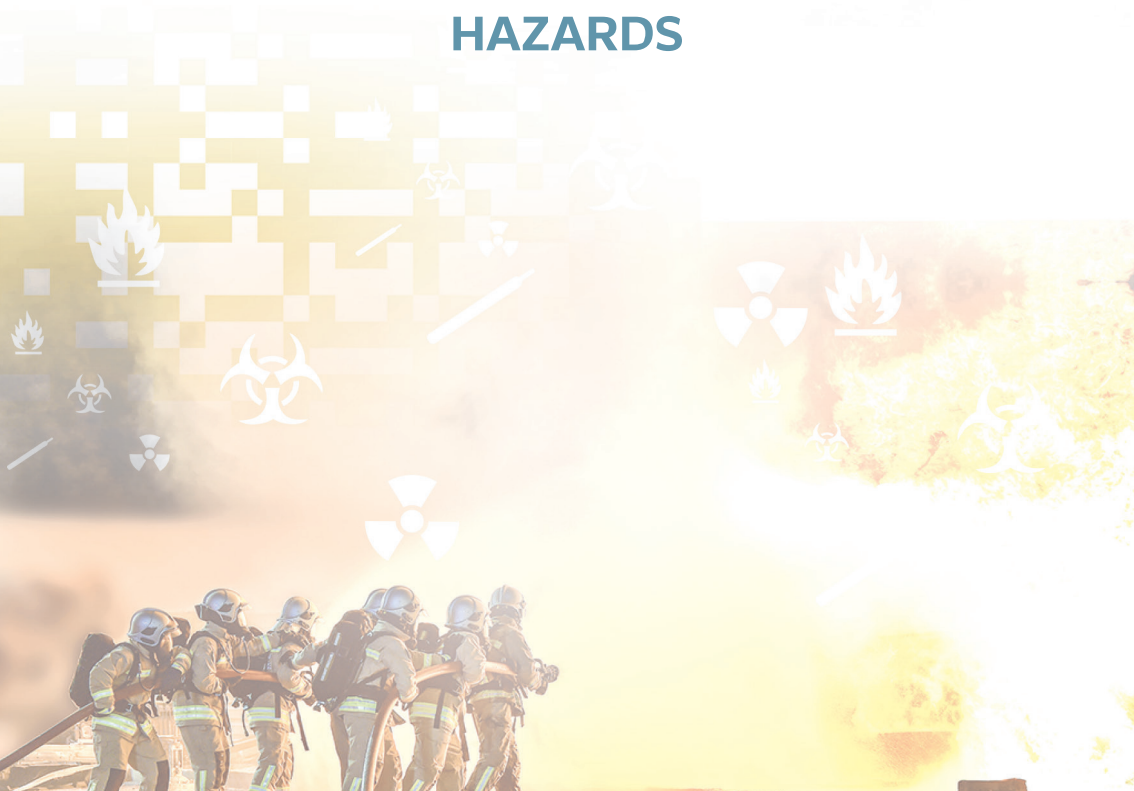
Figure 1 : Internationally recognized dangerous substance labeling according to different classification systems.

Some hazardous substance may not be eligible or may not have available symbol or pictograms to identify the hazards due to their composition, but nevertheless, shall be treated with the same degree and approach to safe storage and handling. This Guidelines also focus on the storage of chemicals in packages or portable containers handled at the workplace or held in temporary storage facilities for more than 24 hours. Similarly, safety precautions for the safe storage of chemicals shall be undertaken.

NOTE: The following hazards are not in the scope of these guidelines and are subject to specific regulations by regulatory authorities prior to subject use of these chemicals.

- Specific measures for explosives.
- Infectious substances.
- Radioactive materials.
- Risks related to transportation.
- Manual operations such as filling and decanting or transferring..

CHEMICAL STORAGE HAZARDS



Chemicals with a Material Safety Data Sheet (MSDS) are likely to be hazardous. Risks might occur when chemicals are released, as a result of leakage due to being stored in the wrong conditions. Moreover, materials are stored in containers, which come in a variety of sizes, shapes, and materials, depending on the type and quantity of the stored material and the required storage method. Containers are used in many industries, including chemical, industrial, agricultural, and medical. For example, metal containers can be used to store liquid chemicals, while durable plastic containers can be used to store solid materials.

It is common to use shelves for storing chemicals, specially designed to store and organize materials safely and efficiently. Storage shelves are available in a variety of designs and materials, depending on storage needs and the general environment of the location. By choosing and using the appropriate storage shelves for chemicals, safe and effective storage of materials can be ensured, protecting workers and the environment from potential risks.

This section covers the duties of management heads and operators inside the storage facility as follows:

The Duties of Management Operators:

- Classifying chemicals according to their hazardous properties.
- Segregating into appropriate container arrangements.
- Labelling the container with prescribed information (Figure 1).
- Accompanying the chemicals with their MSDS and information documents.

Documents shall be appropriately placed/located in the proper commodity/chemical or raw material to ensure the safety and health of the employer and the employees. [Refer to Figure 8.1 storage (Incompatibility table)]

Management heads who are responsible for the chemical storage facility must be aware of:

- Identifying chemicals hazardous to health.
- Complying with the permissible exposure limits (PEL).
- Conducting a chemical health risk assessment.
- Taking action to control hazardous exposure.
- Labeling and relabeling chemicals dangerous to health.
- Providing information, instruction and training.
- Monitoring employee's exposure at the place of work.
- Conducting health surveillance.
- Posting warning signs and keeping records.

In relation to the hazards pose by these chemicals, below is a summary of related effects and possible scenarios, of which:

Possible damage in Storage rooms, containers or shelves are:

3.1 Mechanical Damage.

- In-house transport, possibly in conjunction with poor lighting.
- Overloading of shelves.
- Uneven or sloped floors in the storage room causing leaning or tipping of stored goods.

3.2 Physical Or Chemical Causes.

- Decrease in strength and brittleness of plastics due to lengthy term of storage.

- Light, particularly UV radiation causing plastics to become brittle.
- Decrease in elasticity and brittleness of plastics and metals due to excessive cold.
- Softening of plastics due to excessive heat.
- Corrosion of metallic materials.
- Interaction of the container's material with the stored goods.

3.3 Physical or Chemical Effects For Stored Goods.

- Crystallization and cracking of bottles with aqueous solutions due to cold.
- Increase of internal pressure due to vapor pressure and activation of decomposition in thermally unstable products due to heat.
- Light, particularly UV radiation, activation of violent reactions in substances forming peroxides or products, which may polymerize.
- Duration of storage (including transportation time) triggering of degradation in thermally unstable products.

3.4 Open Handling.

- Filling and pouring.
- Leaving open.

Possible effects are:

1. Fire / Explosion
2. Health hazards

- Irritation
- Poisoning

- corrosion
- Burns due to heat and cold
- Sensitizing
- Breathlessness
- Asphyxia/ Suffocation

(**NOTE**: In addition to the serious hazards to health occurring due to leakage, permanent (long-lasting) effects have to be considered in the case of extended or repeated exposure)

3. Environmental damage.
4. Property damage.

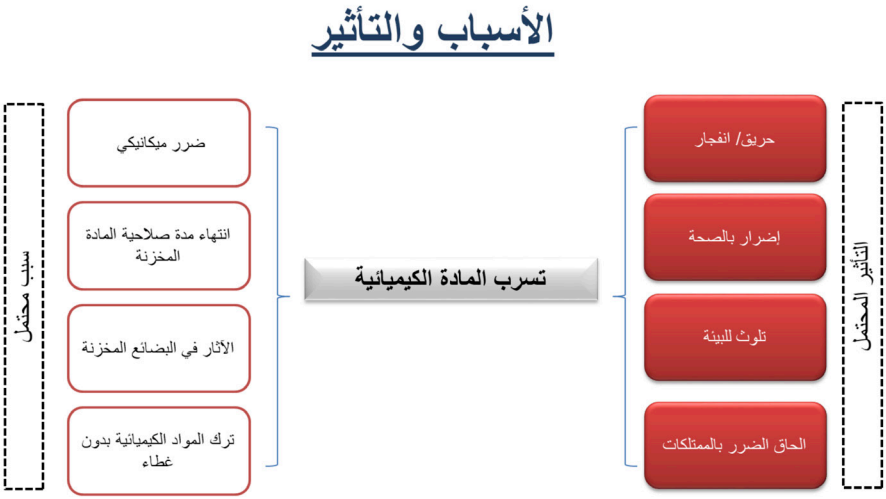


Figure 2: Cause and Effect Framework

CHEMICAL STORAGE AREA OPERATION

Containment of hazardous materials is required for the protection of the environment from contamination as well as for the protection of employees who work in areas where hazardous materials are stored and used.

4.1 Storage Concept

The storage concept represents an overview of the generally accepted safety practices and the mandatory requirements acceptable from the respective authorities to store and handle hazardous substance and chemicals. It is an aid to determine the safety-related deficiencies that must be addressed and the basis for the issuance of approvals and licensing permits by the respective authorities.

Due to the serious risks that may result from the outbreak of fire, safeguarding of employees, members of the emergency services and the public to the threat of radiated heat, harmful smoke and fumes, and widespread distribution of chemicals hazardous to the environment is of valuable importance that must be addressed in the storage concept.

It includes:

- A description of local conditions and surroundings.

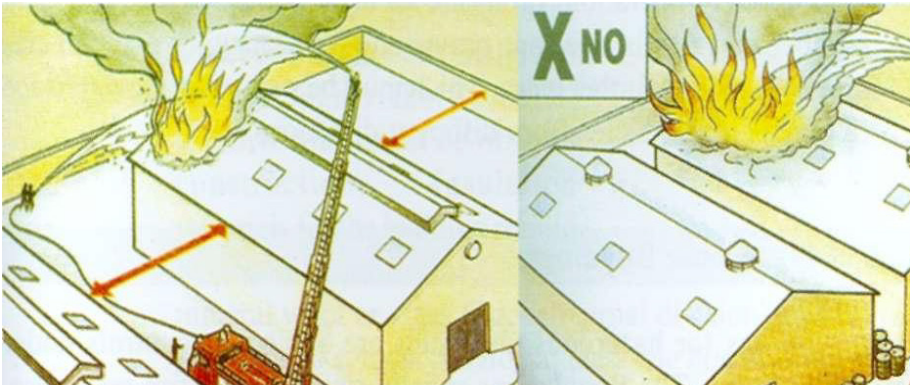


Figure 3. Observance of access road, perimeter storage, and housekeeping

- The description of storage room construction including the fire protection precautions.

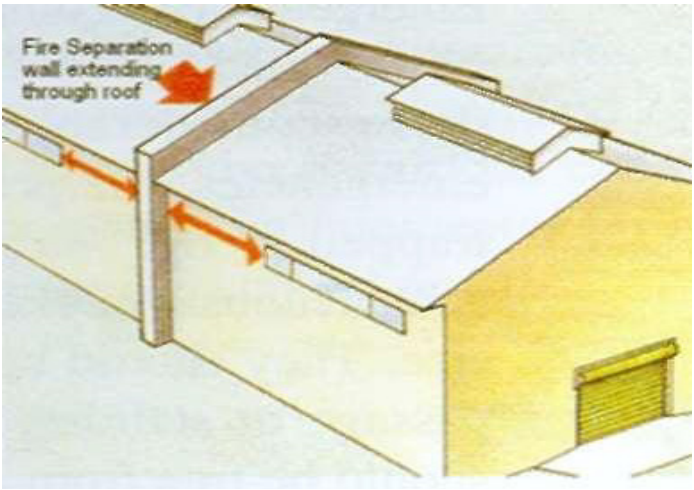


Figure 4: Wall openings and wall penetrations shall be sealed with CDD approved fire-stopping materials of at least 2-hour minimum fire resistance rating.

- The technical and organisational measures.
- The type of storage and the definition of the types of containers to be stored according to :
    1. Properties.
    2. Quantities.
    3. Storage classes.

4.2 Risk Assessment

Risk assessment is a systematic process of identifying potential hazards, evaluating the associated risks, and implementing measures to mitigate or control those risks. This process helps to identify unsafe situations for both people and the environment, enabling decisions on appropriate protective and control measures.

1. **Protective and Control Measures**: Based on the findings of the risk assessment, appropriate protective and control measures need to be implemented before hazardous materials are stored. These measures can include physical barriers, administrative controls, Personal Protective Equipment (PPE), and safety protocols. The goal is to prevent or minimize potential harm to individuals and the environment.

2. **Control Measures**: Different types of control measures can be used to manage the risks associated with hazardous substances:

- Isolation: Isolation involves physically separating hazardous materials from the surrounding environment. This could include using containment systems, such as sealed containers or storage units, to prevent the release of hazardous substances.
- Engineering Controls: Engineering controls are designed to eliminate or minimize exposure to hazardous substances by modifying the equipment, processes, or structures. Examples include ventilation systems, dust collection systems, and automated handling equipment.
- Safe Work Practices: Safe work practices involve establishing protocols and procedures that employees must follow when working with hazardous materials. These practices can include proper handling techniques, storage procedures, and emergency response plans.

3. **Minimization of Hazardous Chemicals**: Minimizing the generation of hazardous chemicals is an important aspect of risk management. This can involve optimizing processes to reduce the production of hazardous byproducts or finding alternative, less hazardous substances.

4. **Spill and Leak Containment**: Controlling the area of contamination in the event of spills and leaks is crucial for preventing the spread of hazardous materials. This can involve installing containment systems, providing spill kits, and training employees on proper response procedures.

Overall, the combination of these measures creates a comprehensive approach to handling hazardous substances safely. The goal is to ensure the protection of workers, the environment, and the surrounding community while maintaining regulatory compliance and ethical responsibility. Regular review and updates to risk assessments and control measures are essential to adapt to changing circumstances and maintain a safe working environment.

To carry out a risk assessment :

4.2.1 Source of information

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

- Labelling (Figure 1).
- The actual version of the safety data sheet (SDS) or material safety data sheet (MSDS).
- Supplementary information from the manufacturer.
- Relevant literature.

4.2.2 Work processes and operating conditions.

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

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

NOTE:

- Uncleaned empty containers and partially empty containers require special attention, and for example, explosive air-gas mixtures can be formed when flammable liquids are or have been in these containers. Therefore, they should 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 may be required.

4.2.3 Potentially explosive atmospheres.

The chance of a chemical explosion can arise due to several conditions and factors, including:

1. **Exposure to high heat**: When certain chemicals are exposed to extremely high temperatures, chemical reactions may occur leading to an explosion.
2. **Exposure to air or oxygen**: Reaction of some chemicals with air or oxygen can generate explosive gases or cause the explosion itself, for example, lithium batteries.
3. **Exposure to intense light**: Some chemicals may be sensitive to intense light such as ultraviolet radiation, sudden exposure to which can trigger chemical reactions causing an explosion.
4. **Exposure to strong shocks or vibrations**: Strong shocks or vibrations can unexpectedly move chemicals, leading to sudden reactions and explosions.
5. **Reaction with other substances**: Chemical reactions with other substances may generate explosive gases or flammable chemicals, increasing the risk of explosions

These conditions and factors are some common examples that may lead to chemical explosions, highlighting the importance of following safety procedures and preventive measures when handling these materials to mitigate accident risks.

Figure 5: Escape routes must not be blocked

4.3 Basic Requirements and Measures for Chemical Storage

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:

- Movement routes.
- Stairways.
- Corridors.
- Emergency exits.
- Escape routes.

Unsuitable 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.

4.3.2 Requirements for Containers and Packaging for Chemicals

Requirements for chemical containers and their packaging vary depending on the type of materials and the occupational safety and health regulations in each country. However, there are some general aspects to consider when packing and storing chemical substances::

1. **Choosing the appropriate container**: It should be compatible with the type of chemical substance, designed to withstand pressure and suitable environmental conditions, and made of materials that do not react with the chemical substance.

2. **Proper container filling**: Chemical substances should be packed in a way that ensures no leakage. Personal Protective Equipment must be provided for workers involved in the filling process.

3. **Labeling and container markings**: Containers should be clearly and accurately labeled with their contents and potential hazards, according to legal requirements and industrial regulations.

4. **Safe storage**: Containers should be stored in a suitable and secure location away from flammable materials or other chemicals that may react with them.

5. **Preventive measures**: Necessary preventive measures should be taken to prevent accidents, such as using protective tools and equipment and providing appropriate training for workers.

It is also important to comply with regulations for transportation, storage, and disposal of chemical substances, in addition to following the recommendations of chemical manufacturers and their safety instructions.

Figure 6: Chemicals should be stored in original containers

4.3.3 Storage Plan /Chemical 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 for rapid determination of the type of stored products and the exact quantities.

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, by hazard class, substance class and storage class.
- Indication on each storage compartment which chemicals are stored there.

Figure 7: Containers must be fixed

4.3.4 Combined storage

Chemicals may not be stored together, if this increases the risk. Storing chemicals with different hazardous properties together may lead to dangerous reactions in the case of simultaneous leakage and mixing.

For instance when,

- Different extinguishing agents are needed.
- Different temperature conditions are required.
- If immediate release and interaction may result in the formation of flammable or toxic gases.
- 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 oxidising chemicals may cause fires or even explosions.

Drugs, food, cosmetics and stimulants must not be stored in the same area as toxic and very toxic chemicals .All other substances must not be stored in the immediate vicinity. It is recommended to refer to Table in (chapter 8.1)

Such "incompatible" chemicals must be kept separately from each other. Furthermore, measures must be taken to prevent them coming into contact in the case of a leakage. Depending on the stored quantity, containers must be placed in separate catch pans or in different storage compartments separated by firewalls.

4.3.5 Managing the storage time in a storage area

Due to the chemical instability of some substances and the limited life of packaging and containers, the exchange of chemicals in a storage area

must be managed carefully. 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).

Figure 8: Storage in order

4.3.6 MSDS stands for "Material Safety Data Sheet."

MSDS stands for "Material Safety Data Sheet." It is a document that provides detailed information about the hazards and properties of a particular chemical substance. MSDSs are primarily used for safety and regulatory purposes, especially in workplaces where hazardous materials are handled or stored. These sheets are designed to ensure that individuals working with, or around hazardous substances are informed about the potential risks and how to handle these substances safely.

Key information typically included in an MSDS may consist of:

1. **Chemical Identity**: The name of the chemical, its synonyms, and identifying codes and manufactory details.

2. **Hazardous Identification**: The components or substances that make up the chemical mixture, including their concentration levels and symbols.
3. **Physical and Chemical Properties**: Information about the appearance, odor, boiling point, melting point, and other relevant characteristics of the substance.
4. **Fire-Fighting Measures**: Details about the substance's flammability, ignition points, extinguishing media and special protective measures and action for fire-fighters.
5. **Health Hazards**: Information about the potential health effects of exposure, including symptoms, routes of exposure, and long-term effects.
6. **First Aid Measures**: Guidelines for providing initial medical assistance in case of exposure or accidents involving the chemical.
7. **Handling and Storage**: Instructions on safe handling, storage conditions, and compatibility with other substances.
8. **Exposure Controls and Personal Protection**: Recommendations for using personal protective equipment (PPE) and implementing controls to minimize exposure.
9. **Physical and Chemical properties**: Information about the substance's stability under different conditions.
10. **Environmental Impact**: Potential effects on the environment and guidance on proper disposal.
11. **Toxicological Information**: More in-depth information about the toxic

effects of the substance on human health.

12. **Ecological Information**: Information about the impact of the substance on ecosystems and wildlife.
13. **Disposal Considerations**: Guidelines for safe and environmentally responsible disposal methods.
14. **Transport Information**: Information about how to handle the substance during transportation, including any regulatory requirements.
15. **Regulatory Information**: Details about regulations and standards that apply to the substance.
16. **Other Information**: Any additional information deemed relevant to the safe handling and use of the chemical.

MSDS is essential tool for ensuring workplace safety, helping workers, emergency responders, and other relevant parties understand the potential risks associated with specific chemicals.

4.3.7 Fire diamond NFPA 704

NFPA 704, also known as the "NFPA Diamond" or the "Fire Diamond," is a standard system used to quickly convey information about the hazards of a chemical substance. NFPA stands for the National Fire Protection Association, a U.S.-based organization that develops and publishes fire safety standards.

The NFPA 704 system uses a diamond-shaped label with four colored sections to provide information about the health, flammability, reactivity, and special hazards of a chemical. Each section is color-coded and assigned a numerical value, ranging from 0 to 4, to indicate the severity of the hazard.

Here's what each section represents:

1. **Blue (Health Hazard):** This section indicates the potential health risks associated with exposure to the substance. The numerical scale ranges from 0 (minimal hazard) to 4 (severe hazard).

2. **Red (Flammability Hazard):** This section indicates the substance's flammability or how easily it can catch fire. The scale ranges from 0 (will not burn) to 4 (very flammable).

3. **Yellow (Reactivity Hazard):** This section indicates the substance's reactivity, which refers to its likelihood of undergoing a chemical reaction that can release energy. The scale ranges from 0 (stable) to 4 (may detonate).

4. **White (Special Hazards):** This section provides additional information about specific hazards, such as whether the substance is an oxidizer (supports combustion), whether water should not be used to extinguish fires involving the substance, and other important safety considerations.

   looking at the NFPA 704 diamond label, emergency responders and workers can quickly assess the potential dangers of a chemical substance and take appropriate safety measures.

HEALTH HAZARD		FIRE HAZARD		REACTIVITY		SPECIFIC HAZARD	
4	Deadly	4	Below 73°F (22.8°C)	4	May detonate	OXY	Oxidizer
3	Extreme Danger	3	Below 100°F (37.8°C)	3	Shock and heat may detonate	ACID	Acid
2	Hazardous	2	Below 200°F (93.3°C)	2	Violent chemical change	ALK	Alkali
1	Slightly Hazardous	1	Above 200°F (93.3°C)	1	Unstable if heated	COR	Corrosive
0	Normal Material	0	Will not burn	0	Stable	W	Use NO WATER

Figure 9: NFPA 704 fire diamond.

4.4 Requirements and Procedures

4.4.1 Responsibilities and Tasks

4.4.1.1. 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 contact with the authorities.
- Compliance with safety regulations (QCDD).
- Selection of suitable employees and care for their further training.
- Collection of information on the material properties (MSDS). For all stored hazardous substances updated safety data sheets

must be available and accessible to employees.

- Provision of personal protective equipment (PPE) to employees and implementation of regular maintenance for this equipment.

4.4.1.2. Employees

- For employees, the following tasks apply:
  - Carry out the work exactly in accordance with the standard operating procedures and instructions.
  - Use and maintain personal protective equipment (PPE).
  - Inform the manager immediately about incidents, near-misses and safety-relevant observations, such as damaged packaging, spills, fires and accidents.

Figure 10: 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 behavior.
- 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.

4.4.3 Safe Behavior

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 safety signs on the wearing of PPE are posted.
- Food and beverages are not consumed in the storage area.
- Hand washing is mandatory before breaks.
- Warnings on special risks such as fire and explosion are presented.
- Ignition sources, which can lead to fires or explosions, are avoided.
- 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.

Figure 11: Warning and advice labels

4.4.4 Personal Protective Equipment (PPE)

As well as technical and organizational safety measures, wearing of appropriate personal protective equipment (PPE) may be required, for instance, when handling contaminated containers, during storage above head height and in the case of leakage.

The protective equipment (depending on particular requirements):

- Protective gloves.
- Safety shoes.
- Helmet.
- Safety glasses.

- Goggles.
- Face shield.
- Protective clothing.
- Respirators.

The employees must wear protective equipment according to instructions.

Regular maintenance (and cleaning if necessary) is required.

Defective PPE must be replaced and safely disposed.

4.5 Operational Failures and Emergencies

4.5.1 Emergency Plan

Each chemical 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 toxicity, as well as, flammable or oxidising substances.

The following information should be included in the emergency plan:

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

The Emergency Plan must be posted where it is 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 behavior in the case of a chemical release, a fire or other 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.

4.5.2. Actions in case of leakage

If chemicals are released, the measures defined in the 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 drain system with chemicals must be prevented by appropriate preventive measures. When only small amounts of liquid are spilled, a suitable absorption agent may be used. The collected waste must be disposed of properly.

Figure 12: Adsorbent and spill cover

4.5.3 Consultation with authorities

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

PLANNING AND DESIGN

Depending on the type and amount of chemicals, the storage area must be located in specially designated buildings.

The intended use and occupancy of the building must be defined in the scope of the project prior to the proposed building construction and features desired.

Fire protection engineering designs must be intended to meet the project requirements and appropriate for the situation. Constraints on the design and project schedule should refer to the quantity and compatibility of the chemicals to ensure that a performance-based design meets the QCDD Fire Safety requirements.

5.1 Approvals

The storage of chemicals may generate a risk to life and property. As a rule, compliance with minimum life safety requirements for the storage design and facility operation is required prior to obtaining an operating license.

Therefore, the storage facility has to be evaluated for life safety compliance and life and property protection before being approved by the QCDD Planning Department. The necessary documents includes :

- The BP (Building Plans).
- Air Conditioning and Mechanical Ventilation System (ACMV)
- Fire Protection (Fire Alarm and Fire Fighting) Plans must contain the details of the design project and fire safety details.

In the case of MODIFICATIONS / CHANGE OF USE / CHANGE IN OCCUPANCY from the previously approved QCDD drawings, the use of the facility will require

a re-evaluation of the existing life safety, fire alarm, firefighting and ventilation systems for any additional safeguards suitable for the protection of the hazard involved.

An UPDATED Modification Drawings of Building Plans, Firefighting System, Fire Alarm System and ACMV System will be required and submitted to QCDD Planning Department approval.

5.2 Location

- Hazardous contents may be stored, dispensed, used, or handled in the controlled areas shown in the approved plans with the sufficient information identifying the class of hazardous materials stored and used in each area. The selected location must be on firm standing ground, protected against flooding and severe weather conditions.
- When storing temperature-sensitive chemicals and liquids with high vapour pressure, excessive heating should be avoided. Chemical mixtures should be classified in accordance with the hazards of the mixture. Multiple hazard contents should conform to the code requirements for each applicable hazard category and waste containing hazardous contents should be classified and disposed of under the facility operating procedures for hazardous waste.
- Storage and location of chemicals should strictly follow the chemical compatibility storage table. Storage markers of luminous yellow color should be visible to floor/ground surface for segregation of commodities. Storage activities should preferably be performed at ground level, chemicals must be stored properly in the designated and controlled chemical store

with sufficient space and storage capacity. Cylinders of liquefied gases may be stored on site to furnish approximately one day's consumption for operation and stored in an approved storage area, but not near exit areas.

- As per policy, no storage of any combustibles are allowed below stairs. No offices or any or other type of room or utility to be above a designated chemical store area.

5.3 Structural Fire Protection

- Buildings or areas where quantities of hazardous materials are stored or used in indoor control areas, the area must be protected by an approved automatic fire sprinkler system. Design and installation shall be in accordance with NFPA 13, Standard for the Installation of Sprinkler Systems.
- The general occupancy of the building or structure should be enclosed with a fire barrier without windows that has a minimum1-hour fire resistance rating or the space protected should be enclosed with smoke partitions.
- Visible hazard identification signs in accordance with NFPA 704, Standard System for the Identification of the Hazards of Materials for Emergency Response, should be placed at entrances to locations where hazardous materials are stored, dispensed, used or handled.

5.3.1. Roofs

- Roofs shall be designed for weather protection and capable to vent heat and smoke during fire.
- The main structure of the roof must be constructed of non-combustible materials that can withstand fire for a duration of

at least 60 minutes and shall be equipped with heat and smoke detector under the roof ceiling.

- The structural supports of roofs shall be designed to resist wind loads and designed with a slope or camber to allow drainage.
- Fire resistance–rated roofs shall be permitted to have openings like Skylights and other penetrations provided that the structural integrity of the fire resistance–rated roof construction is maintained
- The fire-resistive protection of the roof/ceiling assembly shall not be required where every part of the roof/ceiling assembly is 20 ft. (6.1m) or more above any floor.

5.3.2. An Automatic Fire Detection Alarm System

- An automatic fire detection alarm system should be provided in hazardous areas for initiation of the signaling system at an approved, remotely located receiving facility or at a location within the protected building that is constantly attended by qualified personnel.
- Manual fire alarm boxes should only be used for fire protective signaling purposes and shall be located within 60 in. (1.5m) of exit doorways.

5.3.3. Portable extinguishers

- Portable fire extinguishers shall be installed as a first line of defense to cope with fires of limited size and shall be provided throughout the storage area, and shall be maintained in a fully charged and operable condition.
- The selection of extinguishers shall be in accordance with the

hazard and class of fire to be extinguish.

- Class A fires are fires in ordinary combustible materials, such as wood, cloth, paper, rubber, and many plastics;
- Class B fires are fires in flammable liquids, combustible liquids, petroleum greases, tars, oils, oil-based paints, solvents, lacquers, alcohols, and flammable gases;
- Class C fires are fires that involve energized electrical equipment;
- Class D fires are fires in combustible metals, such as magnesium, titanium, zirconium, sodium, lithium, and potassium;
- Class K fires are fires in cooking appliances, that involve combustible cooking media (vegetable or animal oils and fats)

- Portable fire extinguishers shall be permitted to be located at exterior locations or interior locations so that all portions of the buildings are within 75 ft (22.8 m) of travel distance to an extinguishing unit.
- Wheeled fire extinguishers shall be considered for hazard protection areas.
- Dry chemical fire extinguishers shall not be installed for the protection of delicate electronic equipment.
- Only water-type extinguishers shall be installed in areas containing oxidizers.
- Class D fire extinguishers and agents shall be compatible with the specific metal for which protection is provided

5.3.4. Hose system

Fire hoses are an essential component of fire safety and prevention systems in residential, industrial, and commercial buildings. These hoses are used to control and extinguish fires when they occur, serving as an effective means of combating fires in their early stages before fire department teams arrive.

Additionally, regular maintenance is required to ensure the readiness of fire hoses for emergency use. This maintenance includes regular inspection of hoses to ensure there is no damage or leaks, as well as testing water flow to ensure effective spraying when needed.

When designing, installing, and maintaining fire hoses, international standards must be adhered to.

The installation standard for fire hose systems, NFPA 14, provides important guidelines to ensure the effectiveness and safety of these systems, being internationally recognized. These standards cover various crucial aspects such as system design, material selection, installation methods, and maintenance inspection.

For example, NFPA 14 requirements include proper design of fire hose systems, including determining the required number of hoses and their appropriate distribution throughout the building. These standards also specify pressure and water flow requirements for hoses and associated pumps.

Furthermore, periodic maintenance according to NFPA 14 standards includes hose inspection, water flow testing, and inspection of pumps, valves, and other system components to ensure their readiness for emergency use.

5.3.5. Water supplies and fire hydrants

NFPA (National Fire Protection Association) standards provide guidelines for water supplies and fire hydrants, particularly concerning chemical storage facilities. These standards aim to ensure adequate water availability for firefighting purposes and to mitigate the risks associated with hazardous materials.

NFPA 1, Fire Code, and NFPA 400, Hazardous Materials Code, offer relevant guidance regarding water supplies and fire hydrants for chemical storage facilities. Here are some key considerations:

1. Water Supply Capability: NFPA standards typically require chemical storage facilities to have sufficient water supplies for firefighting operations. This includes ensuring an adequate volume of water, appropriate pressure, and reliable sources to support firefighting efforts in the event of an emergency.
2. Fire Hydrant Location: NFPA standards often specify requirements for the placement and spacing of fire hydrants around chemical storage areas. Hydrants should be strategically located to provide convenient access for firefighting equipment and personnel, and they should be spaced at intervals that allow for effective coverage of the facility.
3. Hydrant Maintenance: Regular inspection, testing, and maintenance of fire hydrants are essential to ensure their operational readiness. NFPA standards outline requirements for the inspection and testing of hydrants to verify their functionality and performance.
4. Water Quality: NFPA standards may also address water quality considerations for firefighting purposes, especially when dealing

with hazardous materials. Ensuring that the water supply is free from contaminants and suitable for firefighting is crucial to prevent adverse reactions with hazardous substances.

It's essential for chemical storage facility operators, designers, and fire protection professionals to familiarize themselves with relevant NFPA standards and incorporate their requirements into the design, construction, and operation of water supplies and fire hydrants to enhance safety and compliance.

Class	Color	Rated Capacity
Class AA	Light blue	Rated capacity of 1500 gpm (5680 L/min) or greater
Class A	Green	Rated capacity of 1000–1499 gpm (3785–5675 L/min
Class B	Orange	Rated capacity of 500–999 gpm (1900–3780 L/min)
Class C	Red paint	Rated capacity of less than 500 gpm (1900 L/min)

Table 5.3.5. hydrant capacity NOTE: The capacity colors should be of a reflective-type paint.

5.3.6. Fire Engine Hard Standing

- Fire Engine Hard Standing location and marking should be visible and in accordance with CDD approved drawings for Civil Defense fire engines.
- Fire department access roads shall have an unobstructed width of

not less than 20 ft (6.1m) and vertical clearance of not less than 13ft 6 in. (4.1 m).

- Fences shall not prevent access by fire-fighting/rescue personnel.
- Fire department access roads shall be provided for Sheds and other detached buildings having an area not exceeding 400 ft2 (37.16m2)

5.3.7. Automatic Fire Suppression System (AFSS)

The Automatic Fire Suppression System (AFSS) for chemical storage sites is a vital part of fire protection and safety. This system typically includes a set of elements and technologies for fire detection.

Here are some key elements and considerations for designing an AFSS for chemical storage:

- AFSS typically uses fire detection systems such as smoke detectors, heat detectors, or combination smoke and heat detectors specifically designed for chemical environments.
- Depending on the nature of the stored materials, various suppression agents can be used. Common suppression agents include water, dry chemical agents, foam, and clean agents like FM-200 or CO2. Choosing the right suppression agent is crucial for effectively extinguishing fires without causing further damage or reacting with the chemicals.
- The design and installation of AFSS for chemical storage sites must comply with relevant industry standards and regulations, such as NFPA 400 (Hazardous Materials Code), NFPA 30 (Flammable and Combustible Liquids Code), NFPA 72 (National Fire Alarm and Signaling Code), among others.

Integrating these elements and following to standards, an Automatic

Fire Suppression System can provide effective protection for chemical storage facilities, reducing risks and enhancing safety for personnel, with consideration for maintenance.

5.4 Construction Materials

When it comes to buildings materials for chemical facility, a number of key considerations must be taken into account to ensure safety and compliance with regulations:

1. **Noncombustible Construction Materials**: The building should be constructed using noncombustible materials, including partitions and compartments within control areas. This helps minimize the risk of fire and enhances overall safety.
2. **Fire Barriers**: Control areas within the building should be separated from each other by fire barriers with a minimum 1-hour fire resistance rating. These barriers, including floors and walls, ensure complete separation between different control areas to prevent the spread of fire.
3. **Containment of Liquids**: Floors must be designed to prevent the uncontrolled flow of liquids, including liquefied gases. Additionally, floor coatings should be tight to prevent leakage of water and chemicals.
4. **Drainage Systems**: Storage rooms should be equipped with drains that do not directly lead into the sewage system. This prevents contamination and ensures proper disposal of any spilled liquids.
5. **Surface Characteristics**: Surfaces within the building should be easy to clean and resistant to slipping to maintain a safe working environment.
6. **Static Electricity Control**: Measures should be in place to prevent the accumulation of static charge and dissipate it safely to the ground, reducing the risk of sparks that could ignite flammable materials.
7. **Light-Sensitive Material Protection**: Materials sensitive to light should be stored in containers designed to protect them from exposure, ensuring their integrity and stability.

   By following to these guidelines and using appropriate building materials,

chemical storage facilities can effectively mitigate risks and maintain a safe environment for workers and the surrounding community.

5.5 Access and Transport Routes

The access roads to the warehouse ensure operational efficiency and safety in the storage environment from fires if the following points are considered:

- general site map should be placed at the entrance and exit gates of the building, indicating the location of buildings, external storage buildings, main access routes, evacuation routes and paths, parking areas, internal roads and paths, chemical loading areas, sewage, emergency equipment, and adjacent building uses.
- A map of the building's floors should be posted inside hazardous material storage areas, indicating rooms and halls, entrances, corridors, escape routes, and evacuation routes.
- The hazard class of chemicals in external storage areas should be identified, and the maximum allowable quantities for each class should be determined, using warning signs and labels designed according to the specifications of the National Fire Protection Association NFPA 704.
- Access to chemical storage areas should be restricted to authorized personnel only.
- A suitable training program should be conducted for the types and quantities of materials stored or used, to prepare employees to safely handle hazardous materials on a daily basis and during emergencies.

5.6 Doors, Windows, and Escape Routes

- To ensure a quick evacuation of people in the case of an emergency, all emergency exits and escape routes must be clearly labelled and kept clear at all times.
- Entrance and exit doors at the loading docks must be safe for the workers

to passing by, kept clear all the time and clearly indicated with signs.

- Door openings in a means of egress shall be not less than 32 in. (810 mm) in clear width, must be easily opened outward and must not be key-locked.
- Doors serving high hazard contents shall have a minimum 1-hour fire protection rating and shall be self-closing or automatic-closing with a latch or lock with panic hardware or fire exit hardware.
- fire door assemblies and fire window assemblies and their accompanying hardware, including all frames, closing devices, anchorage, and sills shall be protected by approved, listed, and labeled.
- Fire doors used to protect the means of egress shall be self-closing or automatic-closing.
- Walking surfaces in the means of egress shall be slip resistant.

5.7 STORAGE IN THE OPEN AIR

Storage in the open air presents challenges such as exposure to weather, security risks, and environmental regulations. It is important to protect materials from weather, secure the area against theft, comply with environmental rules, and ensure proper ventilation. Spill containment measures and an emergency response plan should be in place to address potential hazards effectively.

CHEMICAL STORAGE (MACHINERY, EQUIPMENT and FACILITIES)

6.1. Lighting and Electrical Installations

NFPA (National Fire Protection Association) standards related to lighting and electrical installations for hazardous materials storage facilities are crucial for ensuring safety from fires. These standards specialize in the design and installation of electrical systems and lighting in buildings that store hazardous materials.

1. **NFPA 70 (NEC):** Also known as the "National Electrical Code," this standard provides comprehensive requirements for safe electrical installations in all types of buildings, including warehouses containing hazardous materials. NFPA 70 aims to protect people and properties from the risks of fire and electrical shocks.
2. **NFPA 497**: This standard pertains to the design and installation of electrical systems in areas with specified concentrations of flammable gases and vapors. NFPA 497 outlines requirements to mitigate the risk of explosion and ignition in hazardous environments.
3. **NFPA 499:** This standard offers guidance on the classification, design, and safe operation of electrical systems in locations that may contain the risk of ignitable dust, vapors, and other gases.

Implementing these standards helps maintain the safety of workers and properties and reduces the risks of accidents in sites with hazardous materials. To ensure compliance, companies and organizations should familiarize themselves with these standards and adhere to the specifications set by the relevant authorities.

6.2 Storage Systems

6.2.1 Shelves

- 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 in such a way as to prevent products falling. 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.

6.2.2. Containers

- The containers must only be stored in shelves, cabinets and other facilities up to a height, which allows safe storage and removal.
- If necessary, the use of forklifts or supplementary 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.

6.3 Ventilation

Ventilation is very useful in preventing the accumulation of flammable or explosive concentrations of gases, vapors or dusts.

- The storage facility must be well ventilated taking into consideration types of chemical and hazardous substances.
- Ventilation system must be provided in the storage facility, naturally or mechanically after referring to QCDD approved drawing.

- Natural ventilation, for example ventilation through the openings between the double roofing constructions (applicable for open storage).
- Mechanical ventilation, which must be designed by a specialist.

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

Note: The ventilation system must be interlocked with the fire alarm system.

6.4 Air Conditioning

The air conditioning system should be adjusted to maintain suitable temperatures inside chemical warehouses, as appropriate temperatures vary depending on the type of chemicals stored. In addition to air conditioning, chemical warehouses may need to control humidity levels to avoid the risk of fires or hazardous chemical reactions. There should be an effective ventilation system operating alongside the cooling system to evenly distribute cooled air within the warehouses and prevent the accumulation of hot air in specific areas. Installation and operation of cooling systems within the warehouse should also comply with electrical safety standards set by the relevant state authorities.

- Information on safe storage temperatures can be found in Material safety data sheets. These conditions must be taken into account.

Note : The air conditioning system must be interlocked with fire alarm system. In case of fire the air conditioning system should switch off automatically

6.5 FIRE FIGHTING

Firefighting requires providing suitable devices, equipment, and buildings to effectively deal with fires.

Here are some key elements of firefighting:

- Fire Alarm Systems: This includes fire alarm systems, early warning devices, manual fire alarm devices, smoke and heat detectors, as well as alarm and evacuation systems and audible devices to alert workers to safely exit buildings.
- Firefighting Equipment: Various devices such as automatic sprinkler systems, handheld spray devices and hoses. These devices should be available in vital areas and suitable for the type of potential fire. This also includes handheld portable extinguishers, blankets, and other equipment that can be used to deal immediately with small fires.
- Engineering Design of Buildings: Buildings should be designed to facilitate safe escape and reduce the spread of fires, including the use of fire-resistant materials and proper ventilation instructions.

Providing these devices and equipment and implementing preventive measures contributes to reducing the risks of fires and protecting lives and property in the event of fires.

6.5.1. Fire extinguishers

- A storage facility must provide fire extinguishers in a number and capacity that are sufficient for quantity of chemical and hazardous substance in storage and they must be inspected at least once every 6 months.

  (i.e. a 12-kg ABC powder fire extinguisher should be provided at least 1 unit for each 200 m^2 area and two 50-lb ones should be

provided at the flammable liquid storage facility)

- Fire extinguishers must be installed in suitable locations where a map indicating all fire extinguisher locations must be prepared.
- Fire extinguishers must be easily moved and conveniently used.
- Fire extinguishers and signs indicating their locations and directions must be in red color.

Table 6. 1. Types of fire and suitable type of fire extinguishers

Fire extinguishing agent	Types of fires			
	Class A combustible solids	Class B combustible liquids and gases	Class C electrical equipment	Class D combustible metals
Water (portable fire extinguisher)	✓	✗	✗	✗
ABC dry chemical	✓	✓	✓	✗
BC dry chemical	✓	✓	✓	✗
Foams	✓	Yes for liquids No for gases	✗	✗
Aqueous film forming foam (AFFF)	✓	✓	✗	✗
Carbon dioxide	✗	✓	✓	✗
D dry chemical	✗	✗	✗	✓

6.5.2. Firefighting water system

- Fire sprinkler system must be installed in a storage facility at loca-

tions that can sprinkle water or fire-extinguishing-agent over the respective hazardous area.

- In case of the in-rack sprinklers, at least one sprinkler head must be installed every two racks.
- Fire hoses of suitable length and numbers shall be provided to control fire at its earlier stage.
- Hose couplings and hose nozzles must be of the same models or those compatible with the equipment used by the Civil Defence.
- Water hydrant system installed for suppression, generally, are placed at a distance of 50 meters.
- Water supply must be sufficient for firefighting for at least 1 hours.
- There should be dedicated water supply that can be used at a capacity of 100 m3/hr for a less than 2,500 m2 storage facility and 200 m3/hr for a greater than 4,000 m2 storage facility or as per as QCDD approved drawing.

• 6.5.3. Used fire water

NFPA 25 is a code for the maintenance of automatic fire sprinkler systems and fire hydrants used for fire suppression. This standard provides requirements for the maintenance and testing of water-based fire protection systems in commercial and industrial buildings.

It highlights the importance of proper handling of water used in fire suppression. Water discharged from firefighting operations in underground storage areas, for example, must be carefully directed and treated separately to avoid negative environmental impacts and to maintain water quality.

Therefore, companies and institutions must adhere to the guidelines and requirements set forth in local and international standards for proper and safe handling of water used in fire suppression while considering environmental concerns.

6.6 Safety Cabinets

Fire-resistant cabinets are tested according to specific standards to ensure their ability to withstand exposure to fire for a specified period. They are classified into different levels of fire resistance (e.g., one hour, two hours), and it prevent the leakage of materials outside the cabinet. Safety cabinets are often used to store closed containers containing chemicals, and they are typically suitable for storing flammable liquids..

Figure 13: Safety cabinet for flammable liquid

CHEMICAL STORAGE CATEGORIES AND GUIDANCE

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

For the safe storage of chemicals, it is essential to have a comprehensive knowledge of the hazardous properties. Therefore refer to SDS/MSDS. 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 as shown in table 7.1 below.

Table 7. 1. 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 road transportation in Europe		Symbol	Transportation regulation
	UN 1170	UN-number	

According to the Globally Harmonized System (GHS)		Hazard pictogram	Chemical regulation
	Hazard	Single 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	
	F	Symbol Letter	
	R11: Highly flammable.	Risk Phrase (R-Phrase) Safety Advice (S-Phrase)	

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 repro- toxic.

Table 7. 2.Labeling elements and corresponding dangers for toxic materials.

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

Labelling elements	Dangers
	May cause cancer. May cause genetic defects. May cause damage to organs.

Special Measures:

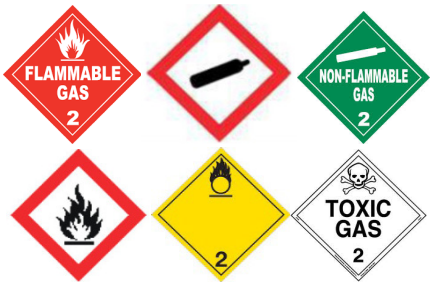
Chemicals with these classifications must be under lock and key or stored so that only qualified people have access. The restricted access must be clearly and permanently visible with the prohibition sign “No access for unauthorized persons”.

7.2 Gases and Aerosols (Aerosol Packaging)

Among the gases and aerosols are:

- Compressed gases
- Liquefied gases
- Refrigerated liquefied gases
- Dissolved gases
- Flammable gases
- Toxic gases

Table 7. 3. Labeling elements and corresponding dangers for Compressed gases

Labelling elements	Dangers
	Gases under pressure may explode when heated. Refrigerated liquefied gases can cause cold burns or injuries.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.

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. It recommended to store gases outside buildings. If they are stored in rooms, these must have sufficient ventilation. Warning signs should make people aware of the suffocation hazard. Therefore, in order to prevent a 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 the case of leakage. 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 reach above 50 °C by exposure to sunlight or any other heat source. Therefore, the storage of such items in shop windows is not recommended.

7.3 Flammable Liquids

Vapors of flammable liquids and vapors can cause fires, deflagrations and explosions.

Extremely Flammable – flashpoint less than 23°C and boiling point lower than 37.8°C.

Highly Flammable – flashpoint less than 37.8°C and boiling point greater than or equals 37.8°C.

Flammable – flashpoint equal to or greater than 37.8°C and less than 93.4°C.

Table 7. 4. Labeling elements and corresponding dangers for Flammable liquids

Labelling elements	Dangers
	Liquids may be 1. Flammable. 2. Highly flammable. 3. Extremely flammable.

Special Measures:

The flashpoint of a liquid is the lowest temperature at which the liquid gives off enough vapour to be ignited (start burning) at the surface of the liquid. . The flash point of flammable and combustible liquids may be altered by the presence of an impurity or additive. It is mandatory to clarify, whether flammable liquids or vapors could be released and form explosive mixtures with air.

Flammable liquids, special attention has to be given to the storage facilities (Chapter 6) and firefighting measures (chapter 6.5).

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 form dust clouds.

Table 7. 5. Labeling elements and corresponding dangers for Flammable solids

Labelling elements	Dangers
	Flammable solids.

Special Measures:

Whether dusts of flammable or combustible solids may be released and form explosive mixtures with air. Therefore, Released dust deposits must always be removed immediately.

7.5 Pyrophoric Substances

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

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.

Self-Heating Substances

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

Table 7. 6. Labeling elements and corresponding dangers for Pyrophoric substances

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

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 chem-

icals should be stored separately (i.e. in a separate fire-rated compartment) if possible or together with non-flammable chemicals.

7.6 Chemicals, Which Emit Flammable Gases When Mixed With Water

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

Table 7. 7. Labeling elements and corresponding dangers for chemicals which emit flammable gases when mixed with water.

Labelling elements	Dangers
	In contact with water releases flammable gases which may ignite spontaneously.

Special Measures:

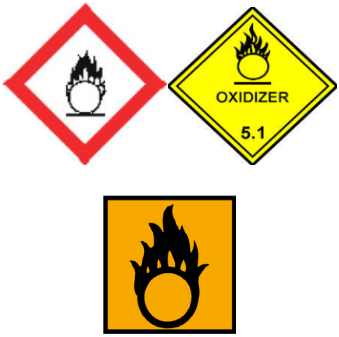
To prevent the emission of flammable gases upon contact with water, firstly, it is necessary to be aware of the chemicals present in the environment that may emit flammable gases and ensure proper labeling. Secondly, these substances should be stored in suitable containers and in areas with sufficient ventilation to minimize the risk of accidental exposure to water. Separate them from water sources or materials containing moisture to prevent improper reactions. Provide training on the risks associated with exposure to water and the necessary preven-

tive measures. By implementing these measures, the risk of emitting flammable gases can be significantly reduced.

7.7 Oxidizing Substances

Oxidizing agents are chemicals that can support a fire without air supply. In a fire, they 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.

Table 7. 8. Labeling elements and corresponding dangers for oxidizing materials

Labelling elements	Dangers
	(Strong) oxidizer May cause or intensify fire (or explosion)

Special Measures:

Oxidizing agents may be stored only in certain conditions with flammable chemicals and materials .These conditions must be taken from the safety data sheets and national regulations or they may result from a risk assessment. Spilled oxidizing chemicals should not come in contact with combustible materials 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 must be stored separately in their own fire rated compartments (applicable for class [5.2]).

7.8 Corrosive Chemicals

Dangerous/Hazardous substances with corrosive properties can damage the skin, eyes and respiratory system and corrode metals.

Table 7. 9. Labeling elements and corresponding dangers for corrosive chemicals

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

Special Measures:

To avoid corrosion resulting from corrosive chemicals, several measures can be taken. Firstly, it is necessary to store the chemicals in appropriate containers made of corrosion-resistant materials, such as glass, plastic, or specially lined metal containers. Sufficient ventilation in storage areas is also vital to prevent the accumulation of chemical vapors, which can accelerate corrosion processes. Additionally, workers should be trained in proper handling procedures to minimize leaks, and they should use personal protective equipment such as gloves, goggles,

and aprons. Regular inspection of storage containers and equipment for signs of corrosion or damage is recommended, and any corroded or damaged equipment should be replaced. Isolating corrosive chemicals from incompatible substances is important to prevent incidental reactions that could lead to corrosion or other hazards. Promptly cleaning up leaks using appropriate cleaning methods and disposing of corrosive chemicals properly according to local regulations and guidelines to prevent environmental pollution and risks.

7.9 liquids with environmentally dangerous properties

Some chemicals can have dangerous effects on the environment when released.

Table 7. 10. Labeling elements and corresponding dangers for liquids with environmentally dangerous properties.

Labelling elements	Dangers
	Very toxic or harmful to aquatic life.

Special Measures:

For the storage of water polluting chemicals, 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 the case of a release.

STORAGE ACCORDING TO HAZARD CLASS AND COMPATIBILITY

The risk associated with incompatible chemicals coming into contact must be avoided wherever chemicals are handled or stored, as when incompatible chemicals react, the generation of energy may be extremely violent, resulting in catastrophic explosions. Gaseous products may be formed which are dangerously flammable, giving off vapors which can rapidly travel outward to an ignition source, thus creating a dangerous fire situation. Reaction products may also release toxic vapors capable of overcoming nearby personnel. Finally, even non-hazardous vapors may be harmful if given off in a great enough volume to displace the oxygen in an enclosed area thus creating an oxygen deficient environment.

The most common chemical storage practice is that of simply storing chemicals in alphabetical order on shelves. This often results in incompatible chemicals being stored together e.g. alphabetical arrangement could result in hydrogen peroxide

(a strong oxidizer) being stored next to hydrazine (a very strong reducer). Chemicals should not be stored alphabetically unless they have first been separated into their hazard classes.

There are no absolute rules on how many classes of chemicals should be segregated. The degree of segregation will depend upon the risk. However, isolation of chemicals into the basic hazard classes will eliminate most accidental adverse reactions that may occur due to breakages or leakages in storage areas.

The tables below shall be applied in order to store the chemicals depending on the storage quantity whereas for laboratory scale storage table 8.2 Chemical compatibility matrix for laboratories shall be applied and for the rest of the cases Chemical compatibility storage table in Table 8.1 shall be applicable.

Table 8. 1. Chemical compatibility storage table.

UN CLASSES OF HAZARD MATERIALS

CHEMICAL CLASS			2				3	4			5		6	8	9
			[2.1] Flammable gases	[2.2] Non flammable gases	[5.1][2.2] Oxidizing gas	[2.3]Toxic gases	[3] Flammable liquids	[4.1] Flammable solids	[4.2] Spontaneously combustible	[4.3] Dangerous when wet	[5.1] Oxidizing agent	[5.2] Organic peroxide	[6.1] Toxic	[8] Corrosive	[9] Miscellaneous
2		[2.1] Flammable gases	A	B	S1	S1	S2	S2	S4	S5	S2	S4	S1	S1	C
		[2.2] Non flammable gases	B	A	B	S1	S2	S2	S4	S5	B	S4	B	S1	C
		[5.1][2.2] Oxidizing gas	S1	B	A	S1	S2	S2	S4	S5	S2	S4	C	S1	C
		[2.3]Toxic gases	S1	S1	S1	A	S2	S2	S4	S5	S2	S4	C	S1	C
3		[3] Flammable liquids	S2	S2	S2	S2	A	S2	S4	S5	S2	S4	S3	S2	B
4		[4.1] Flammable solids	S2	S2	S2	S2	S2	A	S4	S5	S2	S4	S3	S2	B
		[4.2] Spontaneously combustible	S4	S4	S4	S4	S4	S4	A	S5	S4	S4	S4	S2	B
		[4.3] Dangerous when wet	S5	S5	S5	S5	S5	S5	S5	A	S5	S5	S5	S5	S5
5		[5.1] Oxidizing agent	S2	B	S2	S2	S2	S2	S4	S5	A	S4	C	S3	C
		[5.2] Organic peroxide	S4	S4	S4	S4	S4	S4	S4	S5	S4	A	S4	S4	S4
6		[6.1] Toxic	S1	B	C	C	S3	S3	S4	S5	C	S4	A	B	B
8		[8] Corrosive	S1	S1	S1	S1	S2	S2	S2	S5	S3	S4	B	A	C
9		[9] Miscellaneous	C	C	C	C	B	B	B	S5	C	S4	B	C	A

#	Comments and guidance
S1	THE CHEMICALS MUST BE SEGREGATED BY A MINIMMUM DISTANCE OF 3m AND THE STORE MUST BE WELL VENTILATED. SPILL CONTAINMENT MEANS MUST BE OUTSIDE THE CHEMICAL STORE. SOLID HAZARDOUS CHEMICALS MUST BE ON NON COMBUSTIBLE PALLETS TO AVOID CONTANCT WITH INCOMPATIBLE LIQUID CHEMICALS. THE STORE BARRIERS MUST BE FIRERATED.
S2	THE CHEMICALS MUST BE SEGREGATED BY A MINIMMUM DISTANCE OF 5m AND THE STORE MUST BE WELL VENTILATED. SPILL CONTAINMENT MEANS MUST BE OUTSIDE THE CHEMICAL STORE. SOLID HAZARDOUS CHEMICALS MUST BE ON NON COMBUSTIBLE PALLETS TO AVOID CONTANCT WITH INCOMPATIBLE LIQUID CHEMICALS. THE STORE BARRIERS MUST BE FIRERATED.
S3	SEGREGATION OF CHEMICALS MUST BE AS FOLLOWS : (PG III AT LEAST 3m // PG II & I AT LEAST 5m // SOLID HAZARDOUS CHEMICALS AT LEAST 1m).
S4	FIRE RATED PARTITIONED AREA IS PREFERRED FOR THIS CLASS OF CHEMICALS.
S5	FIRERATED DETACHED BUILDING IS PREFERRED FOR CLASS 4.3 WHERE THE USAGE OF WATER BASED SUPPRESSION SYSTEM IS BANNED
A	MSDS MUST BE CHECKED TO GUARANTEE THE COMPATIBILITY OF THE CHEMICALS UNDER THE SAME CLASS . IF THEY ARE INCOMPATIBLE MINIMUM SEGREGATION DISTANCE MUST BE 3M
B	MSDS MUST BE CHECKED TO GUARANTEE THE COMPATIBILITY OF THE CHEMICALS. IF THEY ARE INCOMPATIBLE MINIMUM SEGREGATION DISTANCE MUST BE 3M
C	AT LEAST 3m OF SEGREGATION DISTANCE IS REQUIRED IF THE CHEMICAL HAS FIRE RISK (PRIMARY OR SUBSIDIARY). MSDS MUST BE CHECKED TO GUARANTEE THE COMPATIBILITY.

Table 8. 2. Chemical compatibility matrix for laboratories.

CHEMICAL COMPATIBILITY MATRIX FOR LABORATORIES

CATEGORY		1 FLAMMABLE LIQUIDS	2a ACIDS, INORGANIC	2b ACIDS, ORGANIC	3 ALKALIS (BASES)	4 OXIDIZERS	5 ORGANIC PEROXIDES	6a POISONS, INORGANIC	6b POISONS, ORGANIC	7 AIR / WATER REACTIVES
1	FLAMMABLE LIQUIDS	✓	X	✓	X	X	X	X	✓	X
2a	ACIDS, INORGANIC	X	✓	X	X	✓	X	X	X	X
2b	ACIDS, ORGANIC	✓	X	✓	X	X	X	X	X	X
3	ALKALIS (BASES)	X	X	X	✓	✓	X	✓	X	X
4	OXIDIZERS	X	✓	X	✓	✓	X	✓	X	X
5	ORGANIC PEROXIDES	X	X	X	X	X	✓	X	X	X
6a	POISONS, INORGANIC	X	X	X	✓	✓	X	✓	X	X
6b	POISONS, ORGANIC	✓	X	X	X	X	X	X	✓	X
7	AIR / WATER REACTIVES	X	X	X	X	X	X	X	X	✓

NOTES AND GUIDANCE:

A. KEY:

✓	MAYBE Compatible (Consult Material Safety Data Sheets-MSDS / Safety Data Sheets-SDS)
X	NOT Compatible (do NOT store TOGETHER in the same cabinet)

B. QUANTITY LIMITATIONS:

Storage in Laboratory work areas / per room SHALL not exceed 50liters (13.2gallons) for flammable liquids.

C. INSTRUCTIONS FOR STORAGE AND HANDLING:

The air extraction outlet shall be at least 3m away from any building opening
The minimmum Ventilation of a laboratory containig chemicals shall be 5 air changes per hour
All chemical Bottles and containers shall be sealed and airtight and placed inside the designated cabinet.
All chemical bottles and containers/cabinets shall be properly labeled addressing the hazard group/severity
Drip pans/trays shall be used for liquid chemicals.
Drip pans/trays material shall not react with the contained chemical.
Storage cabinets in laboratory work areas / per room shall be at least 30minutes (0.5-hr) fire resistive construction material and shall be manifuctured as per BS 476.

PROTECTION REQUIREMENTS FOR CHEMICAL STORAGE PER CONTROL AREAS.

General Requirements:

1. Buildings, or portions thereof, containing HIGH HAZARD CONTENTS shall be required to be protected by an approved automatic fire sprinkler system in accordance with the CDD approved plan and applicable provisions of NFPA 13: Standard for the Installation of Sprinkler Systems.

NOTES:

1.1. An automatic sprinkler system shall be installed throughout all occupancies containing areas greater than 12,000 ft^2 (1115m^2) regardless of their hazard of occupancy..

1.2. An automatic sprinkler system shall be installed throughout all mini-storage buildings greater than 2500 ft^2 (232 m^2) for high hazard occupancy.

1.3. Sprinkler system discharge criteria for the protection of hazardous materials shall comply with NFPA 400: Hazardous Materials Code. The design of the sprinkler system shall be not less than ordinary hazard Group 2 in accordance with NFPA 13: Standard for the Installation of Sprinkler Systems.

2. Adequate and reliable water supply shall be provided for fire-fighting purposes.

3. Fire extinguishers shall be provided for the protection of both the building structure and the occupancy hazards contained therein regardless of the presence of any fixed fire suppression systems..

4. The clearance between stored materials and unit heaters, radiant space heaters, duct furnaces, and flues shall not be less than 3ft (0.9 m) in all directions.
5. Clearance shall be maintained to lights or light fixtures to prevent ignition sources or use ant-ignition products.
6. Material safety data sheets (MSDS) shall be available on the premises for hazardous materials regulated.
7. Mechanical ventilation shall be at a rate of not less than 1ft3/min/ft2 (5.1 L/s/m2) of floor area over areas required for ventilation.
8. Doors serving high hazard contents areas with occupant loads in excess of five (5 people) shall be permitted to be provided with a latch or lock only if the latch or lock is panic hardware or fire exit hardware.
9. Number of exit shall NOT be less than two provided from each building, or portion thereof, unless rooms or spaces do not exceed 200 ft2 (18.6 m2), have an occupant load not exceeding three people, and have a travel distance to the room door not exceeding 25ft (7.6 m).
10. The separation of areas containing high hazard contents from each other and from other use areas shall not be less than 2-hours fire resistance rating fire barriers and shall be permitted to be reduced with the installation of fire protection systems.

Specific Requirements:

Warehouse and chemical store for Class [4.3] chemicals shall be protected as follows:

1. Provide MSDS and chemical information documents for the Class [4.3]

chemical warehouse facility that shall be properly placed/situated at the warehouse and chemical store entrance.

2. Signs that read "DO NOT USE WATER" shall be conspicuously placed at the warehouse and chemical store entrance and shall be visible/legible for a distance of 50ft (15.24m).
3. Maintain sidewall clearance of at least 1ft (0.3m) inside storage room.
4. Maintain storage and display height not to exceed 6ft (1.8m) above the finished floor for On-Floor Storage of chemicals.
5. Provide at least 2-hour fire-rated resistance enclosure for the dedicated warehouse and chemical store.
6. Provide fire rated exit door and door assembly with provisions of automatic door closer and panic hardware unit of at least 2-hour fire rated as per as the approved distances from QCDD.
7. Provide a dedicated local fire alarm and detection system inside warehouse and chemical store that shall be supervised in the main fire alarm control panel / control room.
8. Provide manual initiation (Manual Call Points) and audible notification devices (Alarm Bells) near the entrance/exit doors of the warehouse and chemical store.
9. Provide emergency lighting system/units in the warehouse and chemical store.
10. Provide mechanical exhaust ventilation fans in the warehouse and chemical store that shall be maintained functional and operable during the presence of stored chemicals to maintain adequate ventilation and during emergency conditions shall be actuated by fire alarm system.
11. Provide appropriate type of portable fire extinguisher units as per MSDS

recommendations that shall be accessible and located at the entrance and exit discharge locations of the warehouse and chemical store.

12. All vertical wall openings in the proposed warehouse and chemical store shall be sealed with approved fire-resistive materials.

2. Warehouse and chemical store for <u>Class [5.2]</u> chemicals shall be protected as follows:

2. 1 Provide MSDS and chemical information documents for the Class [5.2] chemical warehouse facility that shall be properly placed/situated at the warehouse and chemical store entrance.

2. 2 Maintain side-wall clearance of at least 1ft (0.3m) inside storage room.

2. 3 Maintain storage and display height not to exceed 6ft (1.8m) above the finished floor for On-Floor storage of commodities.

2. 4 Provide at least 2-hour fire-rated resistance enclosure for the dedicated warehouse and chemical store.

2. 5 Provide fire rated exit door and door assembly with provisions of automatic door closer and panic hardware unit of at least 2-hour fire rated resistance rating for a minimum of two (2) means of egress doors and remote from each other.

2. 6 Provide a dedicated local fire alarm and detection system inside warehouse and chemical store that shall be supervised in the main fire alarm control panel / control room.

2. 7 Provide manual initiation and audible notification devices near the entrance/exit access door of the warehouse and chemical store.

2. 8 Provide emergency lighting system/units in the warehouse and chemical store.

2. 9 Provide drainage system and spill sump as secondary containment where it shall be of liquid-tight constructions.

2. 10 Provide mechanical exhaust ventilation fans in the warehouse and chemical store that shall be maintained functional and operable during business operations and during emergency conditions shall be actuated by fire alarm system.

2. 11 Provide appropriate type of portable fire extinguisher units as per MSDS recommendations that shall be accessible and located at the entrance and exit discharge locations of the warehouse and chemical store.

2. 12 All vertical wall openings in the proposed warehouse and chemical store shall be sealed with approved fire-resistive materials.

3. Warehouse and Chemical Stores - <u>LIQUID Chemicals:</u>

3.1 Provide MSDS and chemical information documents for the hazardous storage chemical warehouse and facility that shall be properly placed/situated at the warehouse and chemical store entrance.

3.2 Rack storage arrangement of LIQUID chemicals [i.e. flammable, combustible, corrosive, toxic, and mixtures] shall be approved and shall not be loaded beyond the design capacity and shall strictly follow the chemical compatibility storage table.

3.3 Incompatible materials shall be provided with dedicated spill sump and drainage system.

3.4 Rack storage arrangement of LIQUID chemicals [i.e. flammable, combustible, corrosive, toxic, and mixtures] shall be arranged so that a minimum aisle width of 8ft (2.4 m) is maintained between rows of racks and between racks and adjacent storage.

3.5 Maintain side-wall clearance of at least 1ft (0.3m) inside storage room.

3.6 Provide at least 2-hour fire-rated resistance compartmentation for hazardous storage chemical warehouses and facility.

3.7 Maintain all fire rated exit door and door assembly with pro-

visions of automatic door closer and panic hardware unit of at least 2-hour fire rated resistance rating for a minimum of two (2) means of egress doors and remote from each other.

3.8 Maintain all local fire alarm and detection system inside warehouse and chemical store that shall be supervised in the main fire alarm control panel / control room.

3.9 Maintain all manual initiation and audible notification devices near the entrance/exit access door of the warehouse and chemical store.

3.10 Provide emergency lighting system/units in the warehouse and chemical store.

3.11 Provide mechanical exhaust ventilation fans in the warehouse and chemical store that shall be maintained functional and operable during business operations and during emergency conditions shall be actuated by fire alarm system.

3.12 Provide appropriate type of portable fire extinguisher units as per MSDS recommendations that shall be accessible and located at the entrance and exit discharge locations of the warehouse and chemical store.

3.13 All vertical wall openings in the proposed warehouse and chemical store shall be sealed with approved fire-resistive materials.

4. Warehouse and Chemical Stores - <u>SOLID Chemicals</u>

4.1 Provide MSDS and chemical information documents for the hazardous storage chemical warehouse and facility that shall be properly placed/situated at the warehouse and chemical store entrance.

4.2 Rack storage arrangement of SOLID chemicals [i.e. flammable, corrosive, oxidizers, peroxides and toxic] shall be approved and shall not be loaded beyond the design capacity and shall strictly follow the chemical compatibility storage table.

4.3 Rack storage arrangement of SOLID chemicals [i.e. flammable, corrosive, oxidizers, peroxides and toxic] shall be arranged so that a minimum aisle width of 8ft (2.4 m) is maintained between rows of racks and between racks and adjacent storage.

4.4 Solid pile and palletized storage shall be arranged so that no storage is more than 25ft (7.6 m) from an aisle. Aisles shall be not less than 4ft (1.2 m) wide.

5. Warehouse and Chemical Stores - Laboratory Scale Chemical Reagents

5.1 Provide MSDS and chemical information documents for the hazardous storage chemical warehouse and facility that shall be properly placed/situated at the warehouse and chemical store entrance.

5.2 Implement strict chemical compatibility storage arrangement as per approved Chemical compatibility matrix for laboratories.

5.3 Storage of Class [5.1][5.2] chemicals and Class [4.3] chemicals shall be separated or placed in approved hazardous material storage cabinets.

5.4 Individual containers less than 5gal (19L) or less than 25lb (11kg) shall be stored or displayed on pallets, racks, or shelves. Containers shall be listed or approved for the intended use.

RECOMMENDATIONS:

1. Hazardous materials shall be stored and used in control areas complying QCDD requirements .
2. Occupancies in which high hazard contents are stored, used, or handled shall comply with the applicable material specific requirements and compatibility.
3. The quantity of hazardous materials in an individual control area shall not exceed the Maximum Allowable Quantity (MAQ) for the applicable occupancy.
4. Operations personnel shall be trained in the use of specific safeguards applicable to the dispensing, processing, or use of the materials and equipment employed.
5. Operations personnel shall be trained in the application of storage arrangements and site-specific limitations on storage for the materials employed.
6. Operations personnel involved in materials handling shall be trained in the requirements for on-site transport of the materials employed.
7. Operations personnel shall be trained in the chemical nature of the materials, including their physical hazards and the symptoms of acute or chronic exposure as provided by the material safety data sheet (MSDS) furnished by the manufacturer or other authoritative sources.
8. Operations personnel shall be trained in the necessary actions to take in the event of an emergency, including the operation and activation of emergency controls prior to evacuation.
9. Training shall be provided whenever a new hazardous material is introduced into the work area that presents a new physical or health hazard, or when new information is obtained pertaining to physical or health hazards of an existing hazardous material that has not been included in previous training

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