User’s manual and Construction Requirements for WareHouses in Industrial Cities

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Technical Terminology

- Pallet racks
- Racks
- Loading Bay
- UnLoading Bay
- Loading Dock
- Aisles
- Queuing
- Order Picking
- Staking
- Receiving Docks
- Shipping Docks
- Storage areas
- Staging
- Loading and Unloading areas
- Maneuvering areas
- Marshelling area
- Buffer/Accumulation area
- Dock leveler

- Bulk Storage
- Forklift
- Vans
- Truck
- Trailers
- Swept Turning Circle
Introduction

- Peak Flow Traffic
- Apron Width
- Travel Distance
- Storage Keeping Unit (SKU)
- Reach Truck
- Bins
- Shelves
- Carousels
- Conveyors

The Saudi Industrial Property Authority (MODON) is in charge of several duties, namely planning industrial cities, encouraging their construction, development, management, maintenance and supervision. It also publishes the rules, specifications, performance criteria and procedures pertaining to the construction, development, administration, operation and maintenance of industrial cities. In virtue of article (11) of the internal statute of the Saudi Industrial Property Authority, adopted by the decision of the Authority’s council of administration (5/2003) dated 12/3/1423 Hegira included in article 19 paragraph (3), the conditions of designing buildings inside specific industrial cities and technical and environmental standards and conditions as well as security requirements.

In virtue of article (36) of the internal statute that stipulates that the specified industrial cities should be used for the purposes that they were built for, the Authority must ensure that the beneficiaries comply with all the pertaining technical, architectural, environmental and other standards, specifications and conditions, preserve the environment and collaborate with the public and private stakeholders in order to achieve these goals.
General Conditions of Building Warehouses in Industrial Cities
Chapter 1: General Conditions of Building Warehouses in Industrial Cities

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1.1 Introduction

Title
The set of conditions and regulations included in this guide determines the criteria and conditions of building warehouses in industrial cities in Saudi Arabia, and is shortly referred to in the text as the guide.

Scope of Implementation
The guide’s regulations and conditions are implemented on architectural and building design activities in industrial cities in Saudi Arabia, whether across warehouses planned to be built or existing warehouses that need expansion, restoration, or total or partial destruction, or any rights or privileges pertaining to constructed buildings, while taking into consideration that existing warehouses that were built before the establishment of MODON are treated in a special way in terms of conditions and permits.

Saudi Industrial Property Authority Powers
- Issue and follow-up on the use of this guide in all activities pertaining to industrial cities.
- Explain this guide’s procedures and requirements. Procedures are only amended after a written approval by the Authority.

Update of the Guide
This guide is subject to updates or additions that are required to be implemented, and that are adopted by the Authority, thus becoming an integral part of the guide and share the same powers.

The Guide’s Applicability
1. This guide is subject to all general legal and regulatory provisions and requirements that are implemented in Saudi Arabia, as well as all agreements that Saudi Arabia complies with.

2. Saudi Building Code and international code references adopted by Saudi Standards, Metrology and Quality Organization (SASO) including the related conditions and specifications are considered an integral part of this guide.

3. The latest specific sanitary regulations and conditions published by the Ministry of Health, Saudi Food & Drug Authority, Presidency of Meteorology and Environment (PME) and the General Directorate of Civil Defense are considered an integral part of this guide, and are adopted when the related content is not included in this guide.

4. In case there is a contradiction between one of the guide’s regulations and the codes referential requirements, or it is impossible to reconcile between them in such a way as not to affect the specific conditions, the above-mentioned conditions have the priority in implementation.

5. If any of the design’s documents or the exchanges between the work’s stakeholders refers to a part of or the entire guide as a reference, the latter would have the same binding power as the guide, to the extent allowed by the reference.
1. Comply with this guide’s regulations and conditions.

2. Respect the property rights of those who have adjacent facilities to the project, whether these rights are material or moral.

3. Collaborate with the neighboring project owners and commit to coordinate with them on repair any damages or deteriorations that may affect their buildings due to construction activities in the neighboring building.

4. Not to conclude contracts or mandate any unauthorized offices with design and implementation supervision activities in the Saudi Industrial Property Authority.

5. Prepare designs via a specialized eligible Saudi consultant office in designing warehouses, provided they meet the following conditions:
   a. Sign designs and seal them with the consultant’s office seal.
   b. Attach a valid copy of the office’s permit and submit it to MODON.

6. Verify compliance with work procedures and possession of necessary permits before launching construction activities. No amendment to the design is allowed after the permit is awarded unless amendments to the permit are MODON in order to take necessary measures.
1. Comply with this guide’s regulations and conditions pertaining to design activities.

2. Carry out design activities according to this guide and the international code of design, and prepare documents, designs, technical specifications, quantities and other requirements.

3. Implement international environment standards such as ISO 14001:2004, and occupational health and safety standards such as OHSAS 18001:2004.

4. No amendments to the adopted designs by the Authority are allowed. In case of any modification during the implementation, it should be adopted by the Authority.

5. Any materials that lead under any circumstances to the danger of steam or toxic gas emissions or radiological activities or pollution of the environment are not allowed.

6. Designs and technical standards of activities and quantity lists should be reviewed for compliance with the guide’s conditions and the Saudi construction code, or international standards adopted by Saudi Standards Meteorology and Quality Organization (SASO).

7. It is preferable to comply with sustainability principles when designing warehouses. They can be consulted in Chapter 5 of this guide.

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1. ISO: International Organization for Standardization
2. OHSAS: Occupation Health and Safety Assessment Series 2 for health and safety management systems
1.4 The Supervisor's Obligations

1. Comply with this guide's regulations and conditions.

2. Follow-up on activities carried out by the contractor during the implementation period.

3. Implement international environment standards on location such as ISO 14001:2004 and occupational health and safety standards such as OHSAS 18001:2004.

4. Verify that the contractor clarifies all details of implementation, reports and coordinates all activities providing shop drawings.

5. Handle the exterior aspect of the project's work location.

6. Comply with the norms and regulations that are used for construction sites.

7. Verify the availability of regulatory procedures of warehouses used in the administration of industrial cities.

8. Prepare regular reports on a monthly basis regarding the progress of the implementation of the warehouse's adopted designs, clarifying the compliance with the conditions and standards included in this guide, to be sent to the administration of the industrial city on a monthly basis.
1.5 The Contractor's Obligations

1. Comply with this guide’s regulations and conditions.
2. Comply with the designs and the construction permit content.
4. Comply with technical standards and latest techniques in project implementation.
5. Make sure that all used devices and tools in the building, whether they are security and fire fighting equipment or electrical and mechanical devices, comply with SASO’s requirements or international standards recognized by MODON, in case local standards are not available.
6. Follow technical principles in digging and managing surrounding buildings in order to guarantee their security, while transporting digging equipment outside the location and not storing them in the highway or lateral setbacks.
7. Follow technical principles when demolishing buildings.

**General Warehouse**

Manila, Philippines
1.6 General Conditions for Building Warehouses

1. The warehouse has a permit from the Ministry of Commerce and Industry or the Saudi Arabian General Investment Authority (SAGIA).

2. Warehouses of food, water, medication, bioproducts, sanitary and herbal products that are used for medical purposes, laboratory and diagnostic reagents, as well as medical supplies and electronic devices that affect human health and pesticides, should have a permit from competent authorities, and should follow-up and collaborate with the Saudi Food & Drug Authority in order to guarantee health quality and security of the stored material, and make sure they comply with the criteria of general health, and get acquainted with the conditions and procedures used by the Saudi Food & Drug Authority (WWW.SFDA-GOV.SA).

3. The necessary area for the warehouse should take into account the requirements of storage, loading and unloading areas as well as maneuvering areas.

4. The minimum modern technologies should be provided in the warehouse for vehicles, machines, loading and unloading ways.

5. An adequate area is allocated for each storage warehouse inside the industrial city, after conducting architectural studies, while informing MODON of doing so. Any future expansion activities are taken into account if sufficient justification is provided.

6. Warehouses outside industrial cities are given lands in the industrial cities in case it is decided that it is necessary to relocate them in order to carry out expansion activities to increase their area, according to the governing and obtained permits.

7. The investor uses the planned land to build a warehouse in the industrial cities according to a contract concluded with the Saudi Industrial Property Authority or with the owner of the private industrial city, depending on the nature of the contract, whether it is of leasing, sale or usufruct. The contract binds the warehouse owner to the conditions and requirements of building warehouses inside industrial cities in terms of construction, operation and maintenance.

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3. Municipal and technical conditions for general warehouses, MOMRA.
1.7 Steps to Submit a Request of Building a Warehouse

A construction permit is submitted by following the required procedures that are shown on the MODON’s website, but before doing so, the uploaded conditions on the website are consulted on the following link:

http://www.modon.gov.sa

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Work in Warehouse for Industrial Mechanical Equipment

Boston,
USA
Types of Warehouses and Storage Facilities
Chapter 2: Types of Warehouses and Storage Facilities

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2.1 Introduction

Warehouses are facilities that offer the adequate environment to store goods and materials that require protection from environmental factors and theft. When designing warehouses, many factors should be taken into account such as the capacity of storing the required materials, and lifting and delivery equipment as well as receiving, shipping and transferring operations and the related trucks and trailers, in addition to the needs of employees and workers, provided that lifting and delivery operations are carried out in the shortest time possible in order to achieve economic feasibility in the operation of warehouses.
2.2 Classification of Warehouses

Warehouses are divided into six categories: general warehouses, cold warehouses, controlled humidity, flammable/hazardous storehouses, shed storages, and open storages.

**General Warehouses**

A general warehouse is designed to store pallets, bins, and bulk for specific periods of time until they are merchandised. It operates as an independent facility with a room temperature of 25 degrees, and includes receiving, shipping and loading spaces, as well as storage areas and the necessary aisles and spaces for offices and workers’ services.

**Cold Warehouses**

Cold warehouses are designed to maintain the quality, health, and safety of perishable materials and products and general supply materials that require cold spaces for storage, with temperatures that vary between zero and 4 degrees for chilling, and zero and -16 degrees for freezing. In addition to general warehouses requirements, they include specific spaces for freezing and cooling, as well as equipment facilities and specific areas for mechanical equipment.

**Controlled Humidity**

Controlled humidity warehouses resemble general ones in all aspects, except that they are constructed with steam insulating barriers. They contain control equipment in order to maintain a specific humidity level inside the building. The warehouse building can be separate or adjacent to a general warehouse.

Controlled humidity warehouses are used to store materials for many reasons, namely:

a. Protect technological materials and humidity sensitive materials against deterioration when storing them in general warehouses and preparing them for immediate use.

b. Reduce the initial conservation costs and the re-conservation costs that some products might need when storing them in general warehouses.

c. Preserve materials placed in temporary storage until they are fixed, liquidated, conserved, re-conserved or assembled.

d. Grant full necessary protection for materials that are being treated for conservation.


6. This section does not include storing liquids - oil and non-oil (petrol oil facilities) and open storages.
Flammable/Hazardous Storehouse

Flammable/hazardous storehouses are different from general warehouses because of the dangerous aspect of the stored materials and the measures taken to prevent, eliminate and extract gases and vapors that are generated by the storage of these materials, through appropriate ventilation, and according to the conditions of the Civil Defense for building warehouses and storing flammable/hazardous substances and the criteria and standards of the National Fire Protection Association (NFPA). The substances that are stored as part of this category of warehouses include tints and some petroleum substances, oil and lubricants- POL, chemical substances, acids, corrosive liquids and oxidized substances, as well as other similar flammable and hazardous substances.

Shed Storage

It is a ceiled structure with no lateral or completely finished walls that may contain sprinkler and fire extinguishing alarm systems. This type of warehouses is usually used to store gas, petrol and oil cylinders, lubricants-filled cylinders, trucks, unpolished wood, as well as their construction material. It is noteworthy that shed storages that are used to store hazardous substances are subject to specific design requirements and conditions.
Principles for Planning Warehouse Buildings and Storage Facilities
# Chapter 3: Principles for Planning Warehouse Buildings and Storage Facilities

## 3.1 Determining Manpower and Area Requirements

## 3.2 Principles and Criteria for the Planning of the Warehouse General Location
- General Specifications
- Optimal Distribution of Spaces in the General Location
- Area Requirements for the Flow of Trucks inside the Location
- Orientation of Buildings
- Shapes and Rates of Warehouse Buildings

## 3.3 Design Elements of Warehouse Buildings
- Storage Areas
- Storage Keeping Unit
- Lifting and Handling Systems
- Truck docks & Maneuvering areas
- Support Areas

## 3.4 Elements of the Warehouse and Factors Determining their Relationship
- Cross Flow Layout
- Corner Warehouse
- Through flow

## 3.5 Regulations and Management Rules for Land Uses

## 3.6 Checklist of Third Chapter
3.1 Determining Manpower and Area Requirements

1. Identify the required standards to specify the size of manpower depending on the type of activity and degree of mechanization.

2. Determine the area land requirements, according to the following pattern:
   - Determine the dimensions of the land section (including the warehouse building and the related services like loading, packaging, receiving, shipping, marshalling areas, truck and trailer parking, truck traffic, circulation and maneuvering areas).
   - Determine the warehouse area depending on the type of the storage (storage methods, used loading rack patterns, equipment and vehicles used in material handling operations + main and auxiliary traffic aisles, number of necessary loading bays, shipping and transfer routes inside the warehouse + expansion + site landscape).
   - Determine the shed location’s area (occupancy rate of the warehouse while leaving enough space for unloading, loading, truck parking and movement to store raw substances and end products).
   - Optimized distribution of constructed areas (storage areas + traffic aisles + loading, unloading and staging areas + offices + workers' services + electrical feeding services + maintenance facilities) depending on the type of the warehouse.
3.2 Principles and Criteria for the Planning of the Warehouse General Location

General Specifications

When starting to plan for the general location of the warehouse, the following specifications should be met:

Location Characteristics

Use of the lands surrounding the land section, by consulting the land use map of the surrounding lands to warehouse according to the regulations and conditions implemented in the industrial city.

Traffic and Fire Trucks

Necessary areas for traffic and parking of trucks. in special marshalling areas as well as maneuvering and circulation areas for trucks and fire trucks need to be secured, in addition to loading and unloading areas.

Geographical Locations and Environmental and Natural Factors Surrounding the Location

When designing warehouses, climate factors surrounding the location should be taken into consideration. They are classified as the following:

- Desert areas: When designing warehouses in desert areas, solar radiation intensity, high temperatures, water drainage in the location (floods) and sand winds are taken into consideration.

- Waterfront areas: Among the factors related to designing warehouses in waterfront areas are saltwater, water splash, corrosion, deterioration caused by sea bugs and humidity.

- Mountainous areas: In mountainous areas, consideration must be given to water drainage depending on the location’s topography, ensuring soil stability, and arranging the location so as to adapt to the warehouse building’s design and the main wind direction.

The design principles and criteria for the general location of the warehouse should comply with the following factors:

Optimal Distribution of Spaces in the General Location

- Determine loading bay areas in the best part of the general location in order to achieve the main goals:
  □ Achieve maximal efficiency of entrance and exit of goods.
  □ Capacity for peak traffic flow and types of used trucks in loading and transfer of goods.
  □ Flexibility for future changes and all climate circumstances in the location.
  □ Integration between the general location design and the internal main traffic axes on one hand, and the uses surrounding the location on the other hand.
  □ Comply with loading methods of stored goods that may differ according to the stored goods.

- Determine the truck flow pattern from the entrance gates to the loading and unloading exits so that they are one way or two ways.

Area Requirements for the Flow of Trucks
inside the Location

Area requirements for the flow of trucks inside the location are determined by:

- Determining the number of necessary loading bays for the warehouse.
- Determining the pattern of truck flow (one way or two ways).
- Determining the capability of using vertical exits or diagonal exits with maximum angle inside the location if vertical parking slots are not available.
- Determining docks width
- Determining apron width
- Requirements of parking and queuing

Orientation of Buildings

Orient the buildings allowing to get the most out of indirect sunlight and winds while trying to maximize the compliance with the following criteria by:

- Leveraging indirect sunlight, the transversal north/south part of the building, in order to design a building that reacts positively with the sun trajectory.
- Capacity for buildings shading one another in addition to shading sidewalks (partially or completely)
- Achieving wind effect by orienting buildings within the direction of main winds by putting barriers as one of the possible solutions to protect from strong winds.
- Setting up loading docks against the main wind direction.

Shapes and Rates of Warehouse Buildings

- When starting to design warehouse buildings and determining their rates and shapes, the following elements should be taken into account:
- MinTravel distance between active operational locations and that can be achieved in square areas that extend in a rectangular shape in future expansions of the warehouse, knowing that rectangular surfaces of warehouses allow additional areas to increase loading docks.
- Avoiding the use of irregular shapes such as "U" and "L"
- Future extension and expansion of the warehouse
- Studying the height of warehouses in order to achieve economic efficiency of storage areas.
- Location of the warehouse inside a land area to give flexibility for future extension and expansion of the warehouse
- Location of delivery and shipping offices so as to be neighboring, separate or scattered.

Taking into account traffic and flow regulations in the general location of the warehouse and that may contradict each other sometimes:

1. External flow of heavy trucks
2. External flow of light trucks
3. Workers external flow
4. Pedestrian external flow
5. External flow to/from the warehouse
6. Internal flow inside the main storage areas: entering goods
7. Internal flow inside the main storage areas: exiting goods
8. Internal flow routes between storage aisles.

Complying with the requirements of security and safety in storehouses
By consulting the annex of security and safety requirements in industrial facilities and services in industrial cities, especially Chapter 1 and 4 that include the general conditions to protect against fire in facilities and preventive precautions to protect against fire in warehouse buildings, and that could be summed up as the following:

- Requirements for organizing the location for protection against fire
- Road requirements
- Requirements of controlling fire propagation
- Internal finishings
- Requirements of fire alarm systems
- Requirements of escape routes (exits and stair entrances)
- Requirements of alarm systems and fire extinction inside buildings
- Requirements of warehouses of highly hazardous content

The general location of general warehouses includes a set of main elements such as:
3.3 Design Elements of Warehouse Buildings

1. The warehouse building including:
   - Storage areas
   - Aisles
   - Staging Areas
   - Receiving and Shipping Areas
2. Loading and Unloading Areas
3. Maneuvering Area
4. Accumulation Area
5. Marshalling Area
6. Support services such as:
   - Receiving and Shipping Offices:
   - Administration, worker services and guard
   - Entrance and exit points
   - Truck and car parking slots
   - Special facilities for truck maintenance

Storage Areas

There are four types of warehouses in which storage is made according to the following method:

Stockholding storage

It is usually divided into two parts: one for raw

---

Figure 1: Illustrative plan of the elements of the general location of the warehouse buildings
Transit Storage
This category of warehouses represents a specific phase of the product distribution system and concentrates on storing and distributing raw materials to retail centers (factories, traders, etc.)

Accumulation Storage
In this category of warehouses, necessary components for a specific production procedure are stored.

Repository Storage
This category of storehouses includes specific areas to store vehicles, spare parts for long periods of time. This category is different than the three previous ones, in the sense that its design ensures adequate spaces for storage volume and maximum use of the area that exceeds receiving and maneuvering speed.

Storages
Storage and distribution spaces represent...
the functional area of warehouses and make up for 70 to 80% of the total area, whereas support services occupy between 20 and 30% of the total area. Their design depends on the adequate distribution of areas by using the Storage Keeping Unit (SKU) and the size and type of material handling equipment for stored substances in addition to receiving and shipping requirements. They are usually divided into three categories:

1. Manual Storage
2. Mechanized Storage
3. Automated Storage

When designing manual storage and choosing the adequate operation method, measurements and dimensions that are adequate to human movement are adopted. As for mechanized and automated storage, the related design consists of maximum use of space (area x height) in order to achieve economic efficiency for the warehouse. The "cubic meter" is adopted as elementary unit for design instead of "square meter" in order to achieve maximum stacking and reducing aisles; efficiency in distribution is also adopted instead of stacking, mechanical lifting and delivery equipment instead of manual work. The difference between mechanized and automated storage is that the latter contains holding racks that form part of the constructional building structure, and requires special automated lifting and delivery rules and equipment.

Storage areas are constituted by the following main elements:

7. Warehouse distribution and operations handbook
(1) Pallet racks, Bulk storage and Shelving/bins
(2) Delivery and shipping area
(3) Staging area

**Storage Keeping Unit**

*Figure 5: Illustrative Plan of Storage Elements*
Storage units are considered pallet racks and storage containers, as well as storage requirements and stored material types out of the main elements of storage units the characteristics of which should be taken into account when designing storage areas in warehouses.

Pallet Racks

Pallets racks form a system of staging goods and organizing the storage process. During this process, materials are stacked in accumulative units on a wood or metal surface, known as pallet, with internationally recognized measurements, that is covered with nylon in order to form one block that is compressed in storages in horizontal and multi-leveled lines.

Goods staging method known as pallet is a staging system that simplifies handling, and aims at ordering and stacking goods within accumulative units on a wood or metal surface, known as pallet, with internationally recognized measurements, that is covered with nylon in order to form one block.

Racks

**Table 1:**

<table>
<thead>
<tr>
<th>Pallet Racks Measurements</th>
<th>Measurements (Length mm x Width mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1016x1219</td>
</tr>
<tr>
<td></td>
<td>1000x1200</td>
</tr>
<tr>
<td></td>
<td>1165x1165</td>
</tr>
<tr>
<td></td>
<td>1067x1067</td>
</tr>
<tr>
<td></td>
<td>1100x1100</td>
</tr>
<tr>
<td></td>
<td>800x1200</td>
</tr>
</tbody>
</table>

**Figure 6:** Pallet Racks Measurements
They are metal structures designed to store pallet. They can be free-standing racks or form part of the structural building (structural racks) given that the design criteria of the latter are subject to mechanical and engineering regulations, and need special lifting and handling equipment, which makes future expansion and change processes difficult; they are usually used in elevated and automated storage areas.

Before choosing the type of racks that can be used in storehouses, the following criteria should be studied:

- Exposure of goods to breakage
- Choosing goods storing methods by placing them on pallet racks or storing them in carton boxes and then placing them on pallet racks
- Weight of stored materials
- Easiness of entering and exiting goods from storage areas
- Adequacy of volume of the warehouse building with the volume of goods and stored substances
- Volume of orders and fastness required to be selected according to the used pallet racks

There are several types of racks that are used for staging and for specific purposes that differ according to the volume and shape of the stored material. The types are the following:

**Shelving/Bins**

**Pallet Racks**

**Box storage**

**Code Reference to pack and distribute substances in storage boxes**
### Table 2: Types of racks

<table>
<thead>
<tr>
<th>Types of Racks</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Standard Adjustable Racking</strong></td>
<td>A common type of racks in factories and warehouses, it is made of iron perforated boards that are installed with easy screws according to the required design. This type of racks is simple, flexible and low-cost (like building toys).</td>
</tr>
<tr>
<td><strong>Pallet Racking</strong></td>
<td>The most used type; it is usually linked to the measurements of the used pallet racks or the goods coming from the source.</td>
</tr>
<tr>
<td><strong>Special Racking</strong></td>
<td>It includes special pallets to store steel coils, glass board racks, long racks for textile, carpets or special hung racks for pipes or laminated substances. They are designed for special types of racks to match the characteristics of the stored goods.</td>
</tr>
<tr>
<td>Type</td>
<td>Description</td>
</tr>
<tr>
<td>--------------</td>
<td>-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Live Racking</td>
<td>It includes two types of racks; the type that works via gravity and the other type that works with electricity, by using wheels for light weights and reels for heavy weights. Circular chains with spacious clips that match the pallet’s dimensions.</td>
</tr>
<tr>
<td>Mobile Racking</td>
<td>Mobile and manually controllable racks; They are very common in spare parts warehouses, printing facilities as well as warehouses requiring speed and efficiency in selecting orders and using a wide range of cardboard boxes.</td>
</tr>
<tr>
<td>Structural Racks</td>
<td>Racks that are used as structural elements in elevated warehouses as a replacement for the system of columns that requires unusual dimensions and takes up a large space of the storing surfaces. Using structural racks achieves economic and practical efficiency in the warehouse.</td>
</tr>
</tbody>
</table>
**Bins**: Used to store small pieces such as screws and electronic pieces, etc. This type of shelves can be used for goods that are stored without packaging or in cardboard boxes. Separators are placed inside the shelves in order to organize the small parts of goods within groups, and achieve maximal use of the shelves.

**Shelving**: Common types that are used to store containers and boxes, and irregular shapes.

**Carousels**: They are made of horizontal and vertical containers or irregular shapes with circular horizontal or vertical movements instead of having the worker approaching them, in order to handle or choose the required goods.

**Lifting and Handling Systems**

*Vertical Carousels*  
*Horizontal Carousels*  
*Drawer Bins*  
*Shelves*  
*Mobile Shelves*
Selecting lifting and handling, adequate storage equipment, and the functional characteristics of the warehouse are the main factors that should be taken into account when setting up designs for storages. Choosing lifting and handling systems depends on many factors:

- Shape and weight of the body that needs to be lifted or moved
- Distance of transfer and characteristics of the aisles in terms of width or parallel surface
- Nature of transferred materials (solid - liquid-gas)
- Degree of hazardousness of transferred goods during transfer

There are many types of lifting and handling systems with different functional characteristics that can be used according to the systems and storage keeping units in the warehouse:

- Manual
- Mechanized
- Automated

Automated Storage
Table 3:

Storage System: Manual

<table>
<thead>
<tr>
<th></th>
<th>Long Span Shelving</th>
<th>Tiered Shelving</th>
<th>Raised Storage Area</th>
<th>Cantilever Shelving</th>
<th>Lightweight Live Storage</th>
<th>Fir Tree Racking</th>
</tr>
</thead>
<tbody>
<tr>
<td>3D percentage of space usage (%)</td>
<td>45</td>
<td>45</td>
<td>80</td>
<td>50</td>
<td>65</td>
<td>25</td>
</tr>
<tr>
<td>Percentage of shelf (%) capacity</td>
<td>95</td>
<td>95</td>
<td>50</td>
<td>100</td>
<td>70</td>
<td>70</td>
</tr>
<tr>
<td>Percentage of order selection (%)</td>
<td>Good</td>
<td>Good</td>
<td>Below average</td>
<td>Good</td>
<td>Excellent</td>
<td>Good</td>
</tr>
<tr>
<td>Easiness of goods transfer</td>
<td>Good</td>
<td>Average</td>
<td>Difficult</td>
<td>Average</td>
<td>Very difficult</td>
<td>Best</td>
</tr>
<tr>
<td>Speed of order selection</td>
<td>Good</td>
<td>Average</td>
<td>Below average</td>
<td>Good</td>
<td>Very good</td>
<td>Good</td>
</tr>
<tr>
<td>Cycle of goods</td>
<td>Very good</td>
<td>Good</td>
<td>Below average</td>
<td>Very good</td>
<td>Excellent</td>
<td>Very good</td>
</tr>
</tbody>
</table>
Table 4: 
Mechanized Storage System

<table>
<thead>
<tr>
<th>Block Stacking</th>
<th>Post Pallets</th>
<th>Drive-in Racking</th>
<th>Beam Pallet Racking</th>
<th>Gravity Live Storage</th>
<th>Powdered Mobile Racking</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image_url" alt="" /></td>
<td><img src="image_url" alt="" /></td>
<td><img src="image_url" alt="" /></td>
<td><img src="image_url" alt="" /></td>
<td><img src="image_url" alt="" /></td>
<td><img src="image_url" alt="" /></td>
</tr>
<tr>
<td>3D percentage of space usage (%)</td>
<td>100</td>
<td>90</td>
<td>65</td>
<td>35-50</td>
<td>80</td>
</tr>
<tr>
<td>Percentage of shelf (%) capacity</td>
<td>75</td>
<td>75</td>
<td>75</td>
<td>100</td>
<td>70</td>
</tr>
<tr>
<td>Percentage of order selection (%)</td>
<td>1</td>
<td>30</td>
<td>30</td>
<td>100</td>
<td>30</td>
</tr>
<tr>
<td>Speed of transit</td>
<td>Fastest</td>
<td>Good</td>
<td>Below average</td>
<td>Good</td>
<td>Good</td>
</tr>
<tr>
<td>Exposure of batch to damages</td>
<td>High</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>Sometimes</td>
</tr>
<tr>
<td>Stability of batch</td>
<td>Below average</td>
<td>Average</td>
<td>Good</td>
<td>Good</td>
<td>Average</td>
</tr>
</tbody>
</table>
There are many types of automated storage systems as the storage can be controlled partially or fully with computers in stacking and order selection processes, given that the selection process often requires manual handling especially at the final stage. Automated lifting techniques form a significant part of the warehouse structure and requires special measurements for aisles between shelves. Structural elements usually are 30 meters high, whereas aisles have the least dimensions when lifting and handling are fully automated.

**Material Handling Equipment**

There are three types of lifting and handling tools that vary according to the method of placing goods on shelves and respective containers. They are used for two main purposes: stacking and order picking, and are either manual, mechanized or automated.

**Stackers**

**Mobile lifts**

**Multi-functional lifts**
These equipment are either manual or mechanized (forklifts, small vans) or specially designed (storage/retrieving equipment) for transfer and storage. Forklift is a mechanized truck designed to lift, unload, stack and transfer pallet or goods.

There are many types of available forklifts in the market: Gas, electrical and hydraulic-operating. When starting to plan the design of warehouse, it is necessary to evaluate the transfer equipment that is going to be used in material handling in terms of method of functioning, the adequate width of aisles, additional spaces for circulation, turning requirements and other factors, kindly refer to the list of information on forklifts in the chapter of information list when starting to design warehouses, knowing that this information is only used in the beginning and cannot be relied on in the final design.

**Order Picking Equipment**

This equipment is used to help choose goods depending on a specific order or the transport of the storage. It can be manual or composed (forklifts or vans) or mechanized and designed to catch a specific piece.

**Transport Systems**

Transport systems are designed within the warehouse to transport goods between two or more locations inside or outside the facility. They can be designed to transport packages (pallet or boxes), weights, liquids or solid material.
Truck docks & Maneuvering areas

Truck docks & maneuvering are considered main and complementary elements along with storage, receiving and shipping systems. In storage and distribution facilities, the movement of products starts at the receiving docks in order to receive raw materials and/or enormous quantities of products, and finishes with loading products or consumption goods at the shipping docks. This area tasks are as the following:

- The task of receiving goods is making sure that the supplier received the correct quality and quantity of goods and transferred them to the storage area.
- The task of shipping goods is making sure that the picked goods from the storage area have been transferred to the agent in good conditions in a specific timetable.

Figure 8: Alternatives for the distribution of shipping locations (c) and delivery

(a) the building is located on one road (b) the building is located on an orthogonal road (c) the building is located on two parallel roads.
Loading and Unloading Areas

Loading and unloading areas comprise three main factors:

1. Approach road: is within the storage location and is separated from the main road with an entrance gate.

2. Marshalling area: is a marshalling/buffer area where one can wait before trucks reach the loading and unloading docks. This is considered a vital area that should be secured when starting to design storages because often the specific loading/unloading dock is unavailable when the truck arrives, which causes traffic within the location. Determining area requirements for the marshalling area within the warehouse location is directly located to the following factors:
   - Determining types and number of trucks in peak flow traffic
   - Examination of the traffic surrounding the location as it has influence on the truck movement inside the location in peak flow traffic, especially when the movement of light vans contradicts that of big trucks and conveyors. It is better to separate the movement of trucks of different sizes knowing that the traffic movement is counter-clockwise and allows quick turns of articulated vehicles.
   - Entrances and exits will be explained in detail in the fourth chapter of the guide.

3. Buffer area: It is an additional space designed for truck parking, and allows necessary area for maneuvering and circulation in big warehouses due to truck traffic at the loading and unloading docks. When designing additional buffer areas, the following criteria are taken into account:
   - Surveillance of the administration of these areas by a specialized aisle office.
   - Queuing lanes should be clearly and visually determined while making sure to separate these aisles from maneuvering and circulation areas.

Note:
Providing a maximum number of loading and unloading docks in order to coincide with peak traffic is not feasible economically as providing additional marshaling areas even in small warehouses helps minimizing the number of docks in order to increase storage spaces and provide space for delivery and shipping formalities at the same time.

Figure 9: Illustrative plan of loading, unloading and maneuvering and turning area
Loading and Unloading Docks

Loading and unloading docks offer one or many outlets for truck docks while securing adequate spaces for movement and maneuvering. The design of these outlets, in terms of number, adequate space for movement and parking of tracks, depends on the following main factors:

- Determining the type of goods that need to be loaded and shipped and the necessary period of time for the arrival of trucks to any outlet and unloading the batch
- Type of trucks used to transfer goods (parcel transfer vehicles, outer transfer vehicles 6 meters, measured vehicles 12 - 15 meters, long vehicles 16 meters (for more details, please refer to the list of information related to truck dimensions)
- Expected traffic of aisle of goods
- Future growth of the circulation movement and goods

Support Areas

There is a set of support areas that is functionally separated from the storage area and does not allow direct entrance of workers to the storage area, as fire insulating walls are used in case of availability of hazardous or flammable goods. Adequate spaces are determined for support areas (for more information please refer to the list of information – related to shipping and delivery offices)

Supervisory Offices

There are offices for supervisors such as the warehouse secretary or work team leaders. The location of the offices is near the relevant activity area. The design of the office comprises at least two tables for two people with chairs and drawer to store files. These offices are usually made of pre-fabricated separating walls or another structural form (cement blocks).
### Receiving Office
The main function of delivery offices is to secure an adequate area for security and protection agents and workers in the offices; they include an entrance, a restroom for supervisors and workers as well as separate restrooms for truck drivers.

**Figure 12:** Typical receiving office

### Shipping Office
The main function of the shipping office is to ensure an adequate space for security and protection agents and the delivery office. It includes an entrance and a restroom for supervisors and workers in addition to separate rest rooms for truck drivers.

**Figure 13:** Typical shipping office
Crating Operation
- General storage facilities can require special areas for crating goods of heterogeneous sizes before storing or shipping.

Packing/Packaging
- Packing/packaging spaces are basic requirements in warehouses and are designed to handle small goods/substances. They include an adequate table for work and packing/packaging requirements, cardboard boxes, tape duct, adhesives, labeling cards, a scale. Damaged or hazardous substances are stored in a separate place.

Employee Services
Employee services include lounges, a restaurant, a vending machine for drinks, a room to change clothes and a prayer room. The required area for these services is determined according to the expected number of employees, and there might be need to place these services in different places inside the building so that they are close to the workplace of workers and employees.

Restrooms
Separate restrooms are available for supervisors and workers in the warehouse.

Parking
Pedestrian traffic is represented by the entrance and exit movement of workers. It is a daily movement with a specific fixed schedule that coincides with the movement of trucks and trailers and that should be taken into account when designing parking lots and pedestrian aisles, loading and unloading methods, material handling equipment and transfer systems that are used inside the location, as well as goods liquidation rates.

When designing car parking lots, there should be specific parking lots for all workers in the facility at a close distance of the entrance.
- The entrances should be separated from the exits
- Separating barriers are used between car and truck parking spaces and other activities. The separation is done in the location between the storage facility and other activities in order to guarantee general security.
- Cars are separated from the delivery and shipping areas.
3.4 Elements of the Warehouse and Factors Determining their Relationship

Below are figures of illustrative plans of warehouse models, and that show the work progress and the relationship between the functional elements, characteristics, and flaws of each model.

**Inverted “T” flow**

In this model, shipping and unloading areas are placed closely on one side of the building, with the following characteristics:

- Allocating areas for small, average and high demand of goods minimizes the movement (small demand quantities require longer transfer distance in distant areas)
- Better use of loading and unloading outlets and possibility for common use of mechanical material handling equipment
- Require less space compared to the model that includes separate spaces for loading and unloading
- Possibility to use a loading outlet also for unloading in separate times
- Receiving and shipping of goods in one place allows an easier commercial operation management and ensuring goods against theft
- Flexibility for expansion in three directions

- Allow a better use of outer spaces for the parking of trucks
- The flaws of this method are the following:
  - Central goods storage aisles become crowded in receiving and shipping peak periods
  - The expansion requires a change in the course of goods
  - The transfer distance can be long in bulk storage areas
  - Loading and unloading docks need central management

![Illustrative plan of work in inverted “T” flow storage](image-url)

**Figure 14:** Illustrative plan of work in inverted “T” flow storage
**Cross Flow Layout**

This type of storage is similar to the "T" flow storage but is different in the distribution method of internal storage and order picking areas.

**Corner Warehouse**

This type of storage is similar to the inverted "T" flow but the location of goods entrance and exit is at the corner of the building.

This model is characterized by using the goods distribution method in the management of the warehouse, where storage spaces for goods of important movement are placed at the closest point of the loading and unloading area.

This model’s characteristics are the following:

- In this model receiving storage are separate from shipping areas, the aim being to help provide solutions for situations that might cause contradiction between goods when they are close to each other
- Expansion potential in two directions

The flaws of this method are the following:

- Not appropriate for expansion when the future expansion is a potential as it requires essential changes in the internal traffic in the warehouse
- Requires additional cost for security and surveillance
Through flow

In this type of storage, loading and unloading locations are in opposite directions with the building.

This model is used when unloading requirements are different from loading ones.

The flaws of this technique are the following:

- All stored goods should cross the whole internal distance
- There are challenges in future expansion

Figure 17: Illustrative plan of through flow
3.5 Regulations and Management Rules for Land Uses

1. Commit to the use according to the allocation of areas inside the industrial city depending on type of storages

2. Conformity to conditions and constraints that are attached to the contract of sale or rental in order to make sure that the owner or the leaseholder preserves the buildings and the attractiveness of the city. The applicable conditions and constraints are the following:
   □ Types of land uses (allowed and prohibited) within the industrial city
   □ Improvements to the ground use locations (conditions for the development of the land parcel such as: land occupancy, elevation, built-up area, fences, advertisements, etc.)
   □ Support uses to the warehouse buildings: allocate parking lots for workers' cars in the storage, transport cars, and the area for shipping and unloading operating, a place for workers, and a place to coordinate the location around the warehouse, etc.

3. Prohibit modifications in buildings without a prior authorization from the Authority.

4. Limit the use of building to the ones determined by the sale and lease contracts.

5. Refrain from posting advertisements on the buildings without prior authorization by MODON

6. Refrain from using setbacks or storehouse surfaces for waste storing

7. Refrain from using main roads as marshaling areas for truck parking.

8. Refrain from using lateral or back setbacks to place chillers even if they were lifted from the ground

9. Preserve and maintain buildings and keeping them in good condition

10. The Authority has the right to add other articles to support these items during the growth of the industrial city, such as:
   □ Impose a financial compensation on each tenant or owner for the maintenance of the city according to the suggested regulations of MODON.
   □ Impose fines on violating beneficiaries of the warehouses and demand strict enforcement of regulations.
### 3.6 Checklist of Third Chapter

#### Taking into account the environmental and natural factors surrounding the location

- Consider the location’s topography and geology as well as the soil’s characteristics and the ground’s drainage
- Make use of the environmental circumstances and avoid the related flaws
- Provide an appropriate level of environmental control and natural and artificial lighting
- Minimize noise pollution near other facilities

<table>
<thead>
<tr>
<th>Yes</th>
<th>No</th>
<th>Other</th>
</tr>
</thead>
</table>

#### Provide enough areas for the main elements of the warehouse general location

- Loading/Unloading areas
- Marshalling Areas
- Maneuvering Areas
- Accumulation Areas
- Buffer Areas
- Car and Truck Parking Lots

#### Availability of other main elements in the warehouse

- Storage Areas
- Staging Areas
- Receiving and Shipping Areas

#### Available support services

- Offices of supervisors, receiving and shipping offices
- Staff services
- Crating and staging areas

#### Adequacy of storage regulations according to types of goods

- Manual storage (see table 3)
- Mechanized storage (see table 4)

<table>
<thead>
<tr>
<th>Yes</th>
<th>No</th>
<th>Other</th>
</tr>
</thead>
</table>

#### Availability of adequate areas for transport equipment and swept turning circles

- Adequacy of transport equipment with the width of aisles (see table 2)
- Adequacy of order picking equipment for stored goods (see table 5)
Construction Conditions within the Industrial City
Chapter 4: Construction Conditions within the Industrial City

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4.1 Construction Conditions

Design regulations for the warehouse building block

There are some conditions and standards that are related to designing the block of logistic services and that, if implemented, help create a better industrial environment with positive influence on the design of the warehouse, such as the following:

1. The general location and the warehouse buildings should be placed in a position that allows to directly blocking the view of service and maintenance areas as much as possible.

2. All work areas that face main streets or their adjacent properties should be completely covered with plants, trees or concrete walls allowing the direct blocking of the view.

3. Dismantled car and truck storage spaces should be completely covered with concrete walls.

4. It is necessary to conduct a traffic study in the location so as to meet the needs of the projects and without causing any conflict with the existing traffic on main streets.

5. It is necessary to provide parking lots for trucks and trailers within the location of the warehouse.

Land Occupancy and Rates of Distribution of the Building’s Elements

1. The built up area varies between 50 and 55% at the most out of the land area and is not below 45%.

2. Traffic spaces, internal roads, setbacks, parking lots space, landscape area, loading and unloading area vary between 40 and 45% out of the land area.

3. Floor area ratio does not exceed 1.

4. The Authority must accept an increase of floor area ratio above than 1.5, based on a suggestion of the investor after submitting the documents that prove to do so in the warehouse.

Setbacks

1. The front setback (to the street) is not below 13.5 m, while the lateral and back setback is not below 6 m (including 1 m allocated for the site landscape and a sidewalk of 60 cm width around the building, except loading docks) (table 18)

2. No facility is placed in the setback area, except the electricity room, the main interrupter room, the spare generator, the guard’s room, car parking lots, fuel and gas tanks, and are placed in the front setback.

3. In case secondary streets are 20 and 30 m wide, it is necessary to add a chamfer to the ground of 3 m from each side at an angle of 45 degrees (see table 26)

Figure 18: How to use setbacks- on one road

Figure 19: How to use setbacks- on two orthogonal roads
4. It is possible to use the front setback as a parking for private cars (of a maximal length of 6 m vertically on the fence or open green spaces).

5. It is possible to provide loading and unloading spaces for trucks at the minimum distance mentioned above. In case using car parking lots on the sides of building warehouse, the distance should not be below 12 m, whereas in the case of a marshaling truck area on the side of building, the setback distance is not less than 35 m from the vertical loading docks, 25 m for the diagonal loading docks at an angle of 45 degrees from the boundaries of the land parcel to the limits of the building (including 6 m for the lateral setback) in order to provide space for parking and maneuvering and ensure maximum occupancy rate for facilities inside the warehouse.

**Elevations**

1. The height of general warehouses does not exceed 7.5 m from the ground floor to the lowest point of the ceiling and at any point of hanging fixed equipment from the ceiling.

2. The maximum allowed elevation of warehouses is 30 m from the ground floor to the lowest point of the ceiling and at any point of hanging fixed equipment from the ceiling.

3. The required distance for the movement of order picking equipment is no less than 50 cm from the highest pallet level and the lowest point of hanging fixed equipment from the floor.

4. Elevations vary with storage systems, the type of stored material, the storage technique, as appears in the following plan.

5. In special cases that require increasing the elevation, it is possible to obtain a prior approval of MODON with justification.

**Loading and Unloading Areas Conditions**

*Note:* Dimensions between spans in general warehouses vary between 12 and 30 meters, and ceilings can reach a height of 30 m in order to achieve maximum capacity of storage.

![Figure 20: Elevation conditions](image-url)
Note: Figure 21 shows a model pattern for an automated general warehouse that includes 7.5 m height shelves. The ceiling's height at the lowest point of the inclination reaches 8 m and the distance between spans varies between 12 and 18 m.

Note: Figure 22 shows a model pattern of an automated general warehouse where ceiling's height at the lowest point of inclination reaches 14 m, and where the distance between spans varies between 11.1 and 20 m.

Note: Figure 23 shows a model pattern of an automated general warehouse where structural pallets of the building reach a height of 30 m.
1. The loading and unloading area is identified in the master plan.

2. Consider the easiness of car and truck movement within the warehouse and the absence of obstacles facing movement paths among them with the need to provide the required distance for circulation and maneuvering for trucks, namely large ones.

3. A part of the land area is allocated for loading and unloading activities inside the warehouse according to the following conditions.

**Design Conditions for Loading Docks**

Loading docks are one of the main elements in the beginning and at the end of any storage process. During the design phase, it is necessary to allow easy and safe movement of trucks, trailers and vans and at peak traffic. Their locations should be flexible enough to meet the warehouse future needs, while taking into account all environmental circumstances.

The main factor for the success or failure of the warehouse work flow is determining the adequate number of loading docks with appropriate dimensions. The widths of loading docks vary depending on the "angle of the truck parking, the type of moved goods, the loading technique, and the material handling tools and equipment. Therefore, when beginning to prepare the designs, designers should be in communication with each of:

- Different system designers
- Consultants of mechanical and maneuvering transfer equipment
- Team of storage management
- Technicians in traffic regulation

**Design conditions for orthogonal loading docks - back loading**

The width of the vertical loading dock for back trucks is not below 3.5 m.

- There should be enough space in the loading docks for safe movement and truck turning

![Diagram of vertical loading dock for back loading truck](image)

**Figure 24:** Vertical loading dock for the back loading truck

- When the width of loading docks reaches a minimum of 3.5 mm, the movement and circulation of forklifts are carried out in additional spaces after loading docks, due to little space from the side of trucks (see figure 25-A)
- The width of cross docks that need forklifts (such as cool warehouses) is no less than 4 m, and if the movement of goods is fast, the width of loading docks should be at least 4.5 m (Figure 25 - B)
- Some special cases might require loading docks with width less than 3.5 m in order to increase the number of loading docks in the longitudinal side

8. Cross docks are docks used for loading and unloading.
of the warehouse building. In this case, it is necessary to increase the front progress area of 5 additional meters, which would allow trucks to turn.

- The width of loading docks can reach up to 5 meters for warehouses where provisional preparation processes and marshaling operations are performed at the docks (figure 25- C)
- The required distance for the truck circulation and maneuvering movement is no less than (35 m) from the loading docks knowing that "the increase in the maneuvering distance (40 m) accelerates loading and unloading operations, which is recommended for warehouses that have a fast movement of goods.

**Design conditions for orthogonal loading docks- lateral loading**

*Figure 25: Dimensions of loading docks for back loading vehicles and depths of movement distances*
The width of the vertical lateral loading dock is no less than 7 m in order to provide lateral space to load goods from the sides.

The required distance for the vehicles' circulation and maneuvering movement should be no below 37.5 m for artcis (16.8 m). The distance increases with the vehicles' length, where 42 m for drawbars should be provided that are 18 m long (please refer to the table of sizes, weights and diameters of circulation of trucks and trailers).

**Design conditions for 45 degree inclined loading docks - back loading**

![Diagram of loading docks for lateral vehicles and depths of movement distances.]

*Figure 26: Dimensions of loading docks for lateral vehicles and depths of movement distances*
- The width of 45 degree inclined loading docks is no less than 3.5 m (figure 27)
- The required distance for the movement of trucks and trailers is no less than 18 m from the loading docks if it is not necessary to provide an aisle for trucks passage, otherwise the distance would be no less than 25 m (figure 28)

**Design conditions for shared loading docks**

**Figure 27:** Dimensions of 45 degree inclined loading docks for back loading vehicles

**Figure 28:** Dimensions of movement distances for 45 degree inclined loading docks
- The necessary distance for the movement of vehicles in shared loading docks for different types of shipments, trailers and vans is no less than 35 m from the loading dock.
- If it is not necessary to provide an aisle for trucks, the distance is no less than 25 m (figure 29).
- The width of the loading dock for trailers and trucks is no less than 5 m.
- The width of vans parking lots is no less than 3.2 m.
- The back distance for vans parking lots is no less than 5 m, in order to provide appropriate distance to unload goods.
- When there are two separate entrances for vans and trailers, the depth of the necessary distance for the movement of trucks and trailers is no less than 42.5 m, given that in the location where it is hard to provide this distance on the whole land, the depth of the necessary distance for the movement of vans is allowed to reach 35 m, as appears on figure 30.

Figure 29: Shared loading docks - common entrance for all vehicles

Figure 30: Shared loading docks- separate entrances for common vehicles
Design conditions for loading docks

- There should be an internal aisle aligned to the loading docks of a width of 4 m at the least. It is prohibited to use this type of aisles to place or move goods from the allocated area in order to organize the provisional receiving and shipping process. These aisles are allocated for entrance and exit from the loading dock area and the diverse areas in the warehouses, given that the width of these aisle depends on the aisle movement and transfer tools for goods (manual or mechanized); as the latter requires wider aisles that use manual equipment. Also, two-way aisles are wider than one-way aisles.

- There should be an area to organize delivery and shipping (buffer area) in adjacency to the internal movement aisle, neighboring the loading docks in a linear manner with a depth of no less than 6 m. This area is considered a collection point for goods that need to be shipped, and includes the activities that can be carried out at the area of preparation, packing, collection, supervision of goods as well as review of workers' requests before loading and shipping goods.

- Determining the optimal area for this space has a big influence on the efficiency of the goods delivery and shipping operation, since a small area might lead to crowded loading docks, therefore the damage or loss of goods or partition of shipments, or wrong shipping of goods. It is possible to estimate the necessary area for this space in warehouses by analyzing previous delivery and shipping operations and expect the future growth movements, and implement them on the volume of goods that need to be stored in warehouses that are being constructed, the warehouse manager is consulted in order to estimate the quantities that are expected to be delivered or shipped, in order to determine the required buffer area and the delivery and shipping area.
There should be dock levelers for raised docks, the height of which vary according to the types of trucks and trailers, whereas the height of the raised docks varies between 1 and 1.65 at least, provided that the leveler's height is a little less than the level of loading vehicles in order to prevent sliding of goods towards the vehicle and avoid accidents in case workers are located inside the vehicle.

The inclination of loading dock levelers should not exceed 10% and their depth varies between 2 m and 4.5 m.

Dock shelters should be available to close loading outlets by using shutters in cool storages (please see the chapter on special conditions for cool warehouses), when using them the width of loading docks is no less than 3.7 m.
There should be entrance stairs for people for each 4-5 loading docks.

There should be an canopy placed at the loading docks in case there are no doors, or there were not within the warehouse building. The canopy’s height should be no less than 5 m from the ground floor.

The height of the canopy is no less than 6 m when there are head openings for the loading and unloading vehicles.

The depth of the canopy is no less than 7 m.

**Standards of turning diameter of vehicles of different types and sizes**

Standard specifications of turning diameters (internal and external) of different trucks should be considered when designing movement and maneuvering areas, and that vary according to the type of vehicle used to transport goods from one warehouse to the other:

- Truck
- Trailers
- Vans

**Note:**
In order to provide the necessary protection of the storehouse from collision accidents at the loading and unloading docks, iron poles with circle sections (filled with cement at the docks) should be placed along the canopy width (and the corners of the constructive structure).

**Figure 34:** Illustrative design of high loading outlets with doors and a canopy in case there are no doors available

**Figure 35:** Dimensions of trucks
Below is an illustrative figure for dimensions of internal and external turning circles of a truck and a trailer consecutively as an example for the requirements of maneuvering and circulation areas and that vary according to dimensions of trucks:

**Movement aisles**
- There should be aisles for the movement of the different vehicles in the warehouse namely trucks, trailers and vans (in one circular direction as much as possible)
- The direction of the different vehicles is anti-clockwise
- It is necessary to determine marshaling areas and vehicle parking lots by using signs and floor painting
- Install visual and audio communication equipment in appropriate locations for maneuvering areas and loading docks, in order to maintain a regular aisle movement
- Provide an office to observe operations in the warehouse location and monitor the movement of all trucks as well as loading and unloading
- Provide two offices to monitor the operations of distribution and loading when loading and unloading docks are in separate places

**Open areas**
1. The front yard is used to coordinate the location, and at least 5% of the land's area is allocated for open areas.
2. Coordinate open areas and plant them with permanent green trees and surfaces, pedestrian aisles, unexposed parking lots, while studying their compatibility with entrances and fences.
3. 1 m within the setback from the fence is allocated to coordinate the location and the trees in order to improve the general aspect of the storage. 1 m is also allocated around the administration building to coordinate the location, which is important to:
   - Add an esthetic character to industrial areas
   - Act as a protection factor
4.2 Conditions for Building Design

General Guidelines

Architectural design criteria for warehouse buildings aim at achieving two goals: the first being to ensure a functional homogeneous space and the second one is to make sure that the building is visually special in such a way as to reflect the function of the warehouse, while taking into account the following factors:

▪ The design is simple and modern in architectural patterns, including a various set of adequate architectural materials

▪ Warehouse roofs attract visual interest, while being homogeneous with the logistic context and environment of warehouses

▪ Elevations of warehouse buildings and neighboring buildings should be homogeneous and gradual

▪ It is preferred to use pre-structure engineering steel structures that are architecturally calculated and are lighter than regular steel buildings, and are easier to modify and add. They are also more accurate in the calculation of expected weights on the building.

▪ The economic aspect of steel buildings and the structural cost they usually incur lead to overlook the building’s esthetic aspect. Therefore some recommendations were prepared in order to improve the esthetic aspect of the building, which are the following:

1. Use two homogeneous colors for painting
2. Form a complete building and avoid placing additional top, lateral and front parts
3. Add elements that hide unwanted views on the frontal facade such as tanks and others.

4. Require strict coordination factors for the location that would improve the general aspect of the building and add vitality and void feeling to it

Facades

▪ Pay attention to the design of facades especially in warehouses that are located on more than one road, and that give access to two streets on the front or back facade, they should be clearly emphasized both streets. This is ensured through the finishing material design sustainability of the external facades of the site, design of banners and site landscape design.

▪ The best distance for outer openings of windows vary between 15 and 25% of the wall’s surface, provided that the biggest part of openings within southern facade is designed to provide adequate shading and reduce the acquired direct temperature by exposure to southern sunlight

▪ Bright colored substances that are adequate to hot environments should be used in external finishing works of the warehouse facades and that are represented by:

  ▪ Using bright colored materials on the surface of warehouses in addition to using them on facades; these substances are less absorbent of heat, and they are also highly reflective substance that are measured by the SRI, provided that the design of facade openings prevents bugs, birds, environmental pollutants such as smoke and soil from entering

  ▪ Take care of facades in terms of variety of painting colors and wall patterns
Floors
There is a set of general characteristics that the warehouse floor should have when selecting them:

1. Have enough force to withstand the weights of equipment and installations.
2. The floors should be highly surfaced.
3. Easy to install.
4. Resistant to shocks, scratch, concussions, and not conductive of heat
5. Mild and easy on the eye
6. Healthy and inodorous
7. Ability to absorb sound
8. Alignment is necessary between the floor’s separators, support steel and ground extensions and the vehicle guidance system as well as the requirements of aisles between storage racks, if the warehouse design and internal classification is not determined and subject to changes.
9. The thickness of the floor is no less than 15 cm of reinforced concrete.
10. Consider the structural design of floors in warehouses especially in high facilities, for design purposes related to movement between aisles.
11. Cement is used for 28 days with a pressure no less than 246 kg/cm²
12. Reinforcement steel of a depth no less than 5 cm is placed under the cement surface
13. When placing extension separators, the relationship between them on one hand and aisles and storage racks on the other hand should be taken into account; they should be parallel to the axis line of the aisle, and should be 7.5 cm away from it, as well as far from the material handling tool wheel trajectory.
14. When using floor reinforcing materials such as steel cooler, the equal and balanced distribution on the floor is taken into account.

Service areas
1. Minimum staff services in warehouses should be provided: prayer room - cafeteria - restrooms- buffet- changing room - first aid room; provided that the distances of these units are adequate to the number of workers.
2. The ratio of individuals in the prayer room is 0.8 m²/ worker, and in the cafeteria 1 m²/ worker
3. The first aid room area is no less than 10m²
4. Washrooms, restrooms, a cool water dispenser, taps and light for workers should be ensured
5. Changing rooms (one wardrobe for each worker)
6. It is strictly prohibited for workers or employees to be living within the limits of the storage floor except the guardian’s room
7. Workers are strictly banned from smoking within the warehouse.
4.3 Conditions of the Site Design

Fences
Fences should be from all sides with square-shaped metal sections according to the model adopted by MODON.

The fence is composed of the following factors:

▪ Reinforced cement of ground beams at least 30 cm above the ground surface and based on reinforced cement bases each 5 m.

▪ Main iron poles each 5 m in a 6 x 10 section of a height no less than 2.5 m.

▪ Iron studs in a 3 x 6 section with distances varying between 13 - 15 cm of a height no less than 2.5 m.

▪ Longitudinal iron poles are connected to the fence with iron square or circular iron beams of a 25 mm diameter.

▪ The fence is painted with white/ beige/ grey/ black/ blue Epoxy paint that is resistant to air conditions.

▪ Warehouses fences that give access to roads are painted with the color associated with the region of the warehouse and determined by the industrial city’s administration.

▪ Put lighting on the main pole locations with headlamp lighting of 100 (Watt) globes, according to the technical standards for fences adopted by MODON.

Figure 38: Fences

Figure 39: Adjacent Gates

Figure 40: Separate Gates

Entrances and Gates
1. Each warehouse should have at least 2 gates with a minimum width of 9.5 m when the gates are separated or 6.5 m when they are adjacent.

2. Warehouse gates can only be opened to main roads when their width is 40 m or more, after prior alignment with the Authority in order to modify entrances and exits according to the models adopted by MODON to fit with the entrance and exit movement from and to the warehouse as well as the depth of entrances and gates with the movement on main roads.

3. Each warehouse has a special gate for the entrance of staff and workers.

4. The height of external doors is identical to the height of 2.5 m fences, whereas internal fences should not have an inferior height to that of external gates.

5. The design of the warehouse should take into account providing special entrances for people with disabilities.

6. External gates should be designed so as to fit with the form of the fences, while taking into consideration simplicity and innovation in design and using modern techniques for observation and surveillance.
Docks

1. There needs to be a dock around the buildings of the warehouse with a thickness of no less than 60 m and a height of 15 m from the level of roads surrounding production rooms.

2. The minimum width of rings roads surrounding the warehouse is 6 m.

3. Concrete tiles, interlock, a cement or asphalt layer are used in tiling.

![Figure 41: Docks](image)

Advertisement Banners

1. The warehouse commits to posting an advertisement banner with the name of the warehouse according to the model adopted by the Authority (as appears in the photo). Otherwise, it is prohibited to place and fix advertisement banners on the warehouse building or any other place, whether the fences or the roofs of administrative buildings.

2. The banner is made of aluminum and fits the following specifications:

   - Technical standards: Height of 275 cm and width of both sides. Advertisement facade 121 x 200 cm and width 245 cm.

   - Structure of the banner: Aluminum profile two pieces section 1 aluminum pipe thickness 3 mm diameter 13 cm. Section 2 Aluminum thickness 4 mm external diameter 15 and 85 cm Front and back facade of the advertisement: Aluminum cladding thickness 4 mm white color.

   - Advertisement banner material: Vinyl 3 M to print the slogan, gradient colors fixed on the cladding. Axa sticker (3 M beehive) Crystal cut computer (plotter) for the names of warehouses and slogans.

   - Paint: Anodizing pole paint resistant to heat, humidity and natural factors, color white.

   - The banner is fixed on a cement base 50 x 50 cm of reinforced iron Sabic 14 mm, and ready-made cement cubes of pressure 320 N handled. Painted stainless screws treated against corrosion, 8 for each board.

   - The Authority places the advertisement board through a contractor it determines, and holds the warehouse responsible for the costs.

![Advertisement banners adopted by the Saudi Industrial Property Authority](image)
Site Landscape

1. It is necessary to provide landscape and greenery in the site so as to form a buffer zone between the warehouse and non-industrial facilities. It is possible to use open areas to create natural buffer zones between industrial and non-industrial areas.

2. There needs to be a plant bed at the limits of the fences within the limits of the land area, at the front, lateral and back limits, of a minimal width of 1 m.

3. The site landscape and the greening process should be assigned to a contractor specialized for this type of activities.

Contouring of the Main Road Network

Facilitate the movement of entrance and exit from the warehouse, so that final level height of internal roads does not exceed that of the road asphalt in front of the warehouse by more than 35 cm.

Figure 42: Contouring of the main road network
4.4 Utilities

Natural and Industrial Lighting

1. Ensure natural lighting in the upper parts of the workplace in order to get better quality lighting for the work environment and reduce the cost of industrial lighting.

2. The levels of lighting should be appropriate with the utilization places and should comply with the adopted specifications.

3. The lighting of storage areas is natural unless the function of the warehouse requires otherwise, lighting openings should have enough space no less than 10% of the facade area. It is also recommended to have natural lighting through the ceiling's openings, provided that the distances and percentages are carefully studied by the project's engineers so that the ceiling opening lighting does not exceed 15% out of the total area of the ceiling. All of this while taking into consideration that the lighting, be it natural or industrial, does not exceed the building's temperature.

4. Ensure a shading system on the Southern, Eastern and Western facades of the building, as a way to allow the entry of natural lighting, but also to reduce the radiance of direct sunlight into work places.

5. Natural lighting should be provided for the buildings of staff facilities.

6. The manufacturer commits to light the fences with lighting units that are resistant to air factors, of a minimal capacity of 100 Watts for each 5 m along the fence.

7. The manufacturer commits to light the internal roads inside the manufacturer's real estate with lighting units that are resistant to air factors, and with an appropriate capacity to nature and needs of the factory operation system.

8. External lighting should be connected to an independent distribution board in the guard's room. Attention should be paid not to connect any additional loads, and in case of an expansion of the factory, new circuits are added to the board or a new board is assigned, that is controlled in the guard's room. The lighting of fences complies with the model design.

9. An integral description should be submitted with the standards of the used lighting units and plugs of all types, as well as wires, cables and distribution boards.

Figure 43: Provide natural lighting
Conditions and Requirements for Ventilation and Conditioning Activities

1. Maintain the ventilation of administrative buildings, service buildings, workers' buildings, warehouses as well as other buildings included in the project in order to prevent air pollution and depend on natural ventilation when possible.

2. It is required to provide cross ventilation in spaces where there is a possibility to place opposite openings, while taking into account the distance between these openings.

3. Openings of the buildings are studied in order to keep up with the main wind direction, especially when the wind holds smoke and pollutants from neighboring locations or from the same location.

4. Consult design instructions for an effective ventilation through the criteria ASHRAE 6.2.1 2010 (Ventilation for Acceptable Indoor Air Quality) and CIBSE APPLICATIONS MANUAL (AM10) (Natural Ventilation in Non-Residential Buildings).

5. Diversity in natural ventilation through roof openings and outlets, according to the nature of the void’s use.

Air Conditioning

1. Air conditioning activities for warehouses and administrative buildings should be equipped with a programmed control and operating system.

2. Air conditioning and ventilation related conditions should be considered, while performing the necessary calculations, observing the general and special considerations stipulated in the Saudi general specification and standard specifications as well as the conditions of the Civil Defense and other standards like ASHRAE or ARI, while taking into account the requirements of the NFPA system concerning general safety.

3. The warehouse must not install independent cooling units in case district cooling and steam services were provided by the suppliers.

4. It is forbidden to use separate conditioning devices in warehouses unless a prior approval has been obtained according to the circumstances of the location, the quality of the product, the availability of central cooling services in the city. It is also prohibited to establish or install air conditioning devices on the external facades of the buildings of the warehouses or the administration.

5. It is prohibited to place central cooling units on warehouses roofs on the front facade or the lateral setback. The design must therefore offer appropriate solutions for air conditioning, by either increasing the distance of setbacks or through the architectural design without violating the conditions stipulated by this article.

6. The wall sections and the outer roofs and walls must include an appropriate thermal insulator that covers the whole surface in order to reduce the air conditioning load.
7. Attention should be paid to safe operation so that the system or any of its components do not become a source of danger, such as fire, for example but not limited to, is not a cause of the transfer of fire or smoke from one place to another according to the Codes to control the transfer of smoke (NFPA) and the ability of the system to handle and control the smoke produced by fire (NFPA & ASHRAE).

**Mechanical Activities Requirements for Air Conditioning**

- Ventilation rates should be for storage purposes as needed, provided that the following conditions are met (ASHRAE):
- Special air conditioning equipment in food warehouses should be equipped with backup systems and filters as needed.
- The channel building process should be subject to the SMACNA qualifications.
- All air openings should be equipped with sand traps, and all air entrances should be covered with insect nets.
- Environment pollutants including dust, smells, and stuck particles should be treated in the internal ventilation rather than the roof-installed ventilation. The air change rate required in the ASHRAE standards should also be achieved.
- All ventilation devices and conditioning equipment should be designed to function 24 hours and at a maximum outer temperature of 50°C.
- All warehouses must be equipped with ventilation systems.
- Administrative building must be equipped with air conditioning.
- Ventilation should be secured in rest rooms and kitchens at an air change rate that is not below than the requirements in ASHRAE standards.
- Warehouses must be equipped with air conditioning systems and there must be an adequate environment with the type of store substances in terms of preserving an adequate temperature and humidity percentage.
- All wastes must be treated adequately before being discharged to the outside in order to avoid air contamination.
- All control rooms and electricity board rooms must be equipped with air conditioning systems.
- It is required to properly treat water supply and cooled water networks as needed.
- Comply with the requirements of rationalization of electric power in ventilation and cooling.
- Air conditioning equipment must be selected according to accurate calculations and with the least consumption of electricity. Central conditioning devices must be equipped with a control and programmed operating system.
- Conditioned air curtains must be used for doors that are constantly opened in conditioned areas.

**Electricity**

**Electrical activities requirements**

1. It is required to take into account that the consumption voltage in industrial cities is three-phased, 230/400 V, 60 Hertz, 4 wires.
2. Electrical activities must be designed according to Saudi standards issued by SASO or any other world standards.
3. Surrounding air temperature must be estimated at 50° C according to the calculations of electrical activities design for cables and protection devices.
4. An electrical room should be provided to accommodate the company's special
transformers (SEC) and comply with any modifications imposed by the company according to the dimensions of transformers and their special equipment, during the design process and before execution of activities.

5. In general, it is required to comply with the following standards for transformer rooms:
   - The room dimensions should not be less than 4x5 for each transformer, and a minimal height of 3 m, with a ground floor made of pebbles
   - The room must give access to the street
   - The room must be exposed
   - The room must be located on a main street at least 10 m wide, and in case there are more than one street or in case the investor wishes to place it on an secondary street, he can consult the electricity company to consider the possibility of doing so, provided that that the width of the secondary street is no less than 10 m.
   - The room floor level should be at least 0.30 m higher than the sidewalk's level. The implementation of the transformers room should be made according to the designs and standards adopted by the electricity company.

6. The first estimations for required electrical quantities calculate the use of a rate of 70 Watt/m² only for lighting, plugs and ventilation (out of the warehouse area).

7. The electricity company is in charge of supplying industrial cities with required electrical power. The warehouse should coordinate with the competent company's branch on how to supply electrical power (while mentioning the report on required electrical estimations).

8. The standardized electricity company is in charge of supplying the warehouse with required electrical power according to the actual needs to operate production lines, provided that an additional extension is required while increasing the production capacity of the warehouse. It is also required to comply with the warehouse’s electrical feed requirements, the quantitative capacity K.V.A. and the compound capacity K.B.A.

9. The above mentioned requirements are general requirements. In the event of a special case or special requirements, the investor can liaise with the electricity company in order to find solutions that are convenient to both parties.

10. Warehouses and facilities are subject to the above mentioned conditions when loads are less than 16 Mega. Otherwise, they are subject to special treatment and procedures.

11. Main distribution boards should be installed for the warehouse inside the model electricity distribution room. The suggested location for the company’s electricity room must be as close as possible to this room near the high voltage cable path that supplies the location.

12. The floor protection system must be described along with its various components and the standards of used materials, while mentioning the maximum allowed resistance in the grounding set.

13. All special information on wiring and any additional information on distribution boards should be mentioned (including tables of symbols) while indicating the details of any special installments.

14. A spare source of electrical power should be ensured for important factories in order to operate the warehouse during an interruption of general current while meeting the needs of connection procedures between the source and supplying company of electrical power.

Requirements of Electrical Power Use Rationalization

The following requirements must be taken into account for the electrical power rationalization:

1. Choose low consumption machines
2. Order machines in optimal use classification
3. Use adequate thermal insulators for steam and hot/cold air lines
4. Make use of air, gas and other alternative thermal recovery procedures in order to ensure energy for production operations
5. Make use of solar power and wind power systems if possible
6. Isolate buildings from the outside, and isolate roofs
7. Use colors that help increase sunlight reflection
8. Use electronic brakes and magnetic brake intensifiers in order to improve power factories in gas lighting units
9. Use new modern reflectors in lighting units in order to increase lighting yield.
10. Use photoelectric cells to control lighting circle devices.
11. Use timers and void sensor devices in offices
12. Distribute the lighting of one place on more than one key in order to facilitate the control of the cover's lighting of any part in the rooms if needed.
13. Design electrical circuits so as to distribute loads temporarily according the required operating programs.
14. Devices aiming at improving power factories must be used with the main distribution board using the adequate capacity, in case the total warehouse capacity coefficient drops to 0.8.
15. Equip production lines with the electrical power consumption measurement devices.
16. The use of highly efficient and thermal qualified devices is needed.
17. Use highly efficient and low cost lighting (such as fluorescent lamps).
18. Use enough openings to allow natural lighting.

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Telecommunication

1. Each land area is equipped with a phone cable of no less than 5 lines, implemented with the knowledge of the telecom company and as per the adopted standards.
2. Collaborate with the telecom operator in the industrial city
3. Comply with the technical standards for internal installations to be considered when developing the internal design, and that are represented by the following criteria:
   □ All wire extensions inside the building must be invisible inside building constructions, and must be extended in adequate channels (pipes), and must be enough to meet the needs of current and future telecom services.
   □ Wire installations of telecom services must be in separate channels, while electrical wires or any other wires should not be placed inside the channels containing telecom wires, when it is impossible to provide telecom services to these installations by the supplying company.
   □ It is not allowed to use other service circuits (other than telecom) sharing the same wire or cable with telecom circuits.
   □ Welding on wires - if necessary - is carried out in boxes used to extract wires, while avoiding doing them inside a part of the channel’s trajectory between boxes.
   □ Wires and cables are extended to a minimum of 4: wires and 10 cable pairs (inside the channel to the point of service introduction to the building in the location of the share connection box or the “protector“, or the distribution point). In case there are several separate buildings in one warehouse, a cable is extended from each building to the location of the mentioned box, or to one location in the main building, then extracting them to the box's location.
An adequate number of telecom plugs is provided with a minimum of 2 for each room. The telecom company connects the end of the buried service wire or the ends of the second cable pairs, and implements the necessary connections in the shared connection box.

The telecom company is not responsible for providing cables or wires to connect shared equipment or devices after the point of connection in the shared connection box.

The developer uses market-available PVC lines with a diameter of 30 - 50 mm to meet the future needs of telecom wires and cables, and these lines are only used for this purpose.

The use of special wires is required for telecom services as per the adopted standards by the telecom service supplying company.

The exits of telecom services should have typical plugs adopted by the telecom company that are used with four screw plugs or registered jacks (RJ 11) and use a flat surface with the wall on the fixed service exit boxes inside the wall.

Used plugs must be of the manufactured type for telecom service. It is prohibited under any circumstance to use plugs and exits used for electrical power.

A hole is perforated in the external facade of the warehouse fence wall and an open line from the hole to the floor’s surface is done. Then a PVC line of an internal diameter of 100 mm is extended from the end of the line to a depth of 30 cm inside the earth to 15 cm outside the property's limits.

### Conditions and Requirements Related to Sanitary Works

- Sanitary design must comply with the Saudi standards or any other internationally-recognized standards (American - English- German) that are adopted by SASO. The special conditions of the Civil Defense must also be taken into account.

- Utility water and drinking water tanks are separate from the fire extinguishing water tank, while taking into account the rules of the Civil Defense.

- Connect water tanks to the main water supply pipes in the industrial city.

- Connect the fire extinguishing water tank to the main water supply line in the industrial city.

- Irrigation water is in a separate network from the fire extinguishing water tank.

- Storm water drainage is not allowed in the water sewage network.

- It is necessary to comply with health prevention in warehouses that require so, such as food, dairy products, meat and other warehouses. This means that workers must pass through mandatory washrooms upon accessing and after leaving the warehouse.

- It is necessary to separate water supply pipelines from sewage pipelines.

- It is necessary to provide a water treatment system for solid waste before discharging them in the general sewage network, while taking into account environment protection standards according to the document 1401/1402 issued from the Presidency of Meteorology and Environment (PME) or any other annexes.

- Clarify the grey water treatment method and detail its quality.
▪ Treat contaminated water discharged from the warehouse before discharging it in the industrial city’s sanitary sewage water network in case it is more polluted than the limits and standards that are allowed to be discharged in the sewage network.

▪ Refrain from using grey waters for industrial purposes.

▪ Provide ablution spaces, restrooms and kitchens equipped with hot water.

Utility Water/Drinking Water

Utility water/drinking water is defined as the imported water in the industrial city and that is used to meet the needs of workers and other purposes:

1. The source of this water is usually artesian aquifers or desalinated and treated sea water, knowing that it is prohibited to use the water for sale, cooling or washing purposes. Therefore it is required to clarify the use of this water and the necessary quantity throughout the year.

2. External connections of a diameter less than 40 mm should be established near necessary valves with the general network with the knowledge of the water operator in the industrial city.

3. Collaboration with the industrial city’s operator is required.

4. Needs of workers inside the warehouse are estimated at 30 L/individual/day. The irrigation water needs inside the warehouse are estimated at 10 L/day/m².

5. Comply not to exceed the limits for health-damaging materials in water, according to the standards issued by the PME:

Physicochemical Properties:

<table>
<thead>
<tr>
<th>Property</th>
<th>Allowed Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Floating materials</td>
<td>-</td>
</tr>
<tr>
<td>PH</td>
<td>6-9</td>
</tr>
<tr>
<td>Total congested solids</td>
<td>15 mg/L (maximum)</td>
</tr>
<tr>
<td>Turbidity</td>
<td>75 NTU (maximum)</td>
</tr>
<tr>
<td>Temperature</td>
<td>The PME studies the thermal properties of water allowed for each case at a time.</td>
</tr>
</tbody>
</table>

Source: PME, General Environmental Law and Rules for Implementation, 2001

Conditions for Initial Treatment before Discharging to the Central Treatment Facilities

1. These conditions are implemented on polluted water produced by industrial operations before discharging them to the sewage general network. Below are the instructions for initial treatment that show the maximum allowed limits for pollution level in the sewage water.

2. The warehouse commits to set up an internal sewage network that is connected to the general network with external connections of a minimum diameter of 150 mm, with the knowledge of the city water sewage operator. The network must be equipped with an initial treatment system for industrial waste, and the water must comply with the environmental standards stipulated in the Authority’s environmental conditions guide, before discharging it to the general network.

3. Unpolluted surface water and cooling grey water must be discharged after complying with environmental standards.
4. Polluted water with different properties must be separated in special lines, while complying with the conditions of water sewage and initial treatment, before discharging it to the central treatment facilities that are mentioned in the annex of environmental measurements and procedures for industrial facilities and services in the industrial city issued by MODON.

5. Comply with the sewage-related criteria and conditions when the latter is not treated by the general network, according to the general environmental rules and implementation in Saudi Arabia issued by the PME, according to the following tables.

6. The sewage water quantity is estimated at 80% of the total used water quantity.

### Organic physicochemical properties

**Table 8:**

<table>
<thead>
<tr>
<th>Properties</th>
<th>Instructions (maximum, mg/L)</th>
</tr>
</thead>
<tbody>
<tr>
<td>COD</td>
<td>1500</td>
</tr>
<tr>
<td>TOC</td>
<td>1000</td>
</tr>
<tr>
<td>Oil and lubricants</td>
<td>120</td>
</tr>
<tr>
<td>Phenol</td>
<td>150</td>
</tr>
<tr>
<td>Total chlorinated hydrocarbons</td>
<td>0.5</td>
</tr>
</tbody>
</table>

Source: PME, General Environmental Law and Rules for Implementation, 2001

### Physicochemical Properties

**Table 7:**

<table>
<thead>
<tr>
<th>Properties</th>
<th>Instructions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Floating materials</td>
<td>Clear</td>
</tr>
<tr>
<td>Total congested solids</td>
<td>2000 mg/L</td>
</tr>
<tr>
<td>PH</td>
<td>5-10</td>
</tr>
<tr>
<td>Temperature</td>
<td>60° C (maximum)</td>
</tr>
</tbody>
</table>

Source: PME, General Environmental Law and Rules for Implementation, 2001

### Non-organic physicochemical properties

**Table 9:**

<table>
<thead>
<tr>
<th>Name of element</th>
<th>Instructions (maximum, mg/L)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arsenic</td>
<td>0.5</td>
</tr>
<tr>
<td>Cadmium</td>
<td>2.0</td>
</tr>
<tr>
<td>Total chromium</td>
<td>1.0</td>
</tr>
<tr>
<td>Copper</td>
<td>1.0</td>
</tr>
<tr>
<td>Alsanid</td>
<td>1.0</td>
</tr>
<tr>
<td>Lead</td>
<td>0.01</td>
</tr>
<tr>
<td>Mercury</td>
<td>2.0</td>
</tr>
<tr>
<td>Nickel</td>
<td>10.0</td>
</tr>
<tr>
<td>Zinc</td>
<td>Zinc</td>
</tr>
</tbody>
</table>

Source: PME, General Environmental Law and Rules for Implementation, 2001
Storm Water Drainage

1. An independent storm water drainage network is set up and connected to the street level.

2. No drainage pipes are allowed to be established under the storage hall ceilings or the electricity room.

3. Storm water network pipes must be adequate.

4. Storm water network design considerations are as follows:
   - The inspection room bottom level must be at least (30 cm) above the exit
   - Clarify the internal opening measurement that is no less than (60x60 cm)
   - Clarify the rain sewage for building roofs, production connections and vertical drainage pipes in terms of location, measurements and collection rooms.
   - Inspection rooms must be made of cement.
4.5 Solid waste

Definitions

▪ Storage: All operations that are meant to preserve or contain waste or other dangerous, poisonous or radioactive substances for a specific period of time in order to be used, discharged or transferred.

▪ Bin or container: Any transferred and sealed recipient used to maintain or transfer hazardous waste.

▪ Tank: Any fixed and sealed recipient used to maintain accumulated hazardous waste, made of substances like cement, iron, wood or plastic.

▪ Warehouse: Closed or open place that contains a number of bins or tanks that contain hazardous waste, and includes structures, equipment and foundations to guarantee security and any other modifications or additions, if any.

Solid waste

▪ A special area inside the usufruct limits is allocated to store solid waste. Collection machines are allowed to enter the location without hindering the traffic of trucks or any other vehicles from and or to the storehouse.

▪ The size of storage bins is determined according to the quantity of produced waste and is estimated at 50 L per day for each 100 m2 of the warehouse (this rate is used as a general indicator for warehouses since it can differ between warehouses and depends on the type and size of the warehouse). This rate includes all produced waste due to loading, separating, storage activities or any other activities of present workers within the limits of warehouse, including:

  ▪ Cardboard, wood, plastic, metals and others produced by pallets or staging operations.

  ▪ Solid waste produced by worker activities, including humid materials (organic waste, rest of food), and dry materials (plastic, metals, cardboard, paper, etc.).

  ▪ It is recommended, as much as possible, to sort solid waste by separating humid substances from dry substances, and placing them in separate containers in order to facilitate their recycling, after the competent authorities have collected them.

  ▪ It is possible to allocate one or more doors on the loading dock to empty waste directly into a fixed or mobile waste bin. It is recommended to equip the bin with a compactor to compress waste in case the daily produced quantity in the warehouse exceeds 30 m2.

  ▪ It is possible to place the bin inside or outside the warehouse depending on the followed procedure to collect and discharge waste. In case the bin is placed on the loading dock inside the warehouse, it must have external ventilation (figure 51). In both cases, the floor under and around the bin must be sliding. Around the bin, there must be a minimum distance of 1.5 m in all directions, to contain the waste that might fall from the bin.

  ▪ It is recommended to equip warehouses of three or more floors with waste chutes that are connected to the bin in order to facilitate waste discharge.
General health and environmental safety conditions must be respected in waste collection and discharge. Therefore, bins or chutes must be closed and resistant to leakages, and must limit any odor emission.

These bins and tanks are placed in a ceiled warehouse within the location according to the general health and environmental safety conditions, at a minimal distance of 15 m from the limits of the location on all directions. The warehouse's location is chosen in such a way as to limit environmental damages and hazards in case of leakage or any other incident.

Firefighter vehicles must have access to the warehouse in case of fire or in the event of occurrence of any another incident. The location of the warehouse is not affected by natural factors such as floods or torments; the floor of the warehouse must be made of cement or any other insulating material.

In case of storing liquid substances, the warehouse must be equipped with secondary containments surrounding the tanks or bins, and allowing spare capacity storage in case of leakage or incident.

The necessary capacity of these containments is identical to the following instructions:

- If the pool contains one tank: the capacity is equivalent to 110% to that of the tank.
- If the pool contains more than one tank: the capacity is equivalent to 110% to that of the biggest tank in the pool, plus 10% the total capacity of other tanks.

Hazardous waste (solid and liquid)

The PME defines hazardous waste as a type of waste with special characteristics that makes it a threat to human health and to the environment, and that belongs to one of the following categories:

- Poisonous
- Highly reactive
- Flammable or explosive
- Corrosive
- Infectious and radioactive
- Hazardous wastes can interact with each other are separated and stored in separate bins or tanks the size of which is determined depending on the produced quantities. No waste is stored for more than 90 days as of the storage date.
The following general conditions are implemented on all types of warehouses:

- General warehouse
- Cold warehouses
- Controlled humidity warehouse
- Flammable/Hazardous warehouses
- Shed storage
- Health and environmental conditions include:
  - The location must stay away from bad odors, smoke, soil and other pollutants, and must be protected from floods
  - The warehouse is built from adequate and easy to clean deaf substances
  - The floor and walls of the warehouse are made of adequate and easy-to-clean materials
  - There must be marks on the floor of storage rooms for loading dock aisles
  - The design of the warehouse should be well-sealed in order to prevent the entry of bugs and rodents
  - The warehouse must include a complete ventilation system and must be equipped with adequate suction fans
  - The warehouse must be equipped with adequate lighting at a sufficient luminous rate that is provided with electrical lights. It is preferred to use eco-friendly and energy-saving devices.
  - It is preferred to use thermal isolating substances such as an insulator to keep the warehouse temperature stable and unchanged by external thermal variables, in order to prevent excessive use of power for cooling or heating activities.

- Provide safety methods according to the regulations of the Civil Defense
- Comply with complete cleanliness in all the warehouse units
- It is forbidden to use storage aisles
- It is forbidden to consume dust and food inside the warehouse
- It is forbidden to sleep in the warehouse
- It is strictly forbidden to smoke inside the warehouse
4.7 Fire and Explosives

1. It is allowed within the scope of the warehouse to store flammable substances, goods or products as long as they are stored, used and produced inside a protected building from all sides with a resistant network to fire or any other method adopted by the Civil Defense, while consulting the website of the General Directorate of the Civil Defense www.998.gov.sa

2. Comply with the criteria and conditions of firefighting included in the industrial security and safety requirements in warehouses and services in industrial cities, for example but not restricted to (please refer to the annex of industrial safety and security in industrial facilities and services in the industrial city issued by the Authority)

- The width of main aisles is no less than (2 m) and that of secondary aisles (2.5 m) in any case
- The number of exits must comply to general conditions, so that there are no less than two spacious exits at the extremities of the building and on the external wall, each of them leading to the outside, and all exits lead directly to the outside, a staircase or an aisle protected from fire and separated from the building by a buffer zone.
- Use firefighting equipment as stipulated the Civil Defense conditions related to firefighting in warehouses shown in Table 10.

### Table 10:

<table>
<thead>
<tr>
<th>Type</th>
<th>Required cases</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Manual firefighting equipment</strong></td>
<td></td>
</tr>
<tr>
<td>Manual extinguishers</td>
<td>All situations and cases</td>
</tr>
<tr>
<td><strong>Fixed installments</strong></td>
<td></td>
</tr>
<tr>
<td>Rubber hose network</td>
<td>All situations and cases</td>
</tr>
<tr>
<td>Dry nozzle network</td>
<td>Not required</td>
</tr>
<tr>
<td>Wet nozzle network</td>
<td>Not required</td>
</tr>
<tr>
<td>External nozzle network</td>
<td>In highly dangerous warehouse buildings</td>
</tr>
<tr>
<td><strong>Fixed automatic systems</strong></td>
<td></td>
</tr>
<tr>
<td>Automatic network for water sprinklers, fire fighting</td>
<td>Basement - in medium and highly dangerous warehouse buildings</td>
</tr>
<tr>
<td>Automatic network for sprinklers of other substances</td>
<td>Special hazardous places where water cannot be used</td>
</tr>
<tr>
<td><strong>Fire alarm equipment</strong></td>
<td></td>
</tr>
<tr>
<td>Manual alarm network</td>
<td>In all situations and cases</td>
</tr>
<tr>
<td>Automatic alarm network</td>
<td>In medium and highly dangerous warehouse buildings, and highly dangerous places in slightly dangerous warehouses</td>
</tr>
</tbody>
</table>
4.8 Warehouse General Safety Requirements

(As per the conditions of the Civil Defense)

1. Warehouses must be adequately located far from main roads, residential buildings and other facilities.

2. Construction materials used must be non-flammable especially in warehouses that are aimed at storing highly flammable substances.

3. Provide at least two storage locations located as far as possible from each other and in two different directions.

4. Stored materials must be lined in an organized way, preferably on shelves.

5. Provide aisles between lines in order to allow workers or security guards in the warehouse to reach any point in case of a fire, with a minimum capacity of 1.5 m.

6. The pallet's height must not reach the ceiling's level, and the distance between lines and ceilings is no less than 91.5 cm.

7. Stored materials especially perishable ones must be lifted from the warehouse floor by at least 7.5 cm.

8. Each type of substances is stored separately in order to recognize the proper method of firefighting.

9. All wires and electrical devices must be secure and correctly installed.

10. Lighting must be good and appropriate, and placed above aisles and places that are not exposed to accidents.

11. Provide fire detection devices.

12. Provide automatic firefighting system.

13. Discharge waste, pack residues, and distribute cover-equipped barrels for that purpose.

14. Maintain organization and cleanliness inside the warehouse and neighboring places at all times.

Note: Please consult the guide on industrial safety and security requirements in warehouses.
### 4.9 Checklist for Chapter 4

#### Comply with the distance percentages inside the land area according to the following rates

<table>
<thead>
<tr>
<th>Description</th>
<th>Yes</th>
<th>No</th>
<th>Not required</th>
</tr>
</thead>
<tbody>
<tr>
<td>▪ Total built-up area: 50% - 55%</td>
<td>☐</td>
<td>☐</td>
<td></td>
</tr>
<tr>
<td>▪ Total movement void area, parking area, and loading and unloading area between 40%-45%</td>
<td>☐</td>
<td>☐</td>
<td></td>
</tr>
<tr>
<td>▪ Open areas for site landscape: 5%</td>
<td>☐</td>
<td>☐</td>
<td></td>
</tr>
</tbody>
</table>

#### Comply with the following setbacks

<table>
<thead>
<tr>
<th>Description</th>
<th>Yes</th>
<th>No</th>
<th>Not required</th>
</tr>
</thead>
<tbody>
<tr>
<td>▪ The front setback is no less than 13.5 m</td>
<td>☐</td>
<td>☐</td>
<td></td>
</tr>
<tr>
<td>▪ The lateral setback is no less than 6 m</td>
<td>☐</td>
<td>☐</td>
<td></td>
</tr>
<tr>
<td>▪ Refrain from establishing any facilities in the setback except electricity room, main interrupters, spare generator, the guard's room gas and oil tanks.</td>
<td>☐</td>
<td>☐</td>
<td></td>
</tr>
<tr>
<td>▪ In case there was a car parking on the sides of the warehouse building, the distance between the limits of the land area and the warehouse building (lateral setback) is no less than 12 m</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>▪ In case there were vertical parking slots for trucks on the sides of the warehouse building, the distance of the lateral setback is no less than 35 m.</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>▪ In case there were diagonal parking slots for trucks by a 45° angle on the sides of the warehouse building, the distance of the lateral setback should be no less than 25 m.</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
</tbody>
</table>

#### Comply with the following heights

<table>
<thead>
<tr>
<th>Description</th>
<th>Yes</th>
<th>No</th>
<th>Not required</th>
</tr>
</thead>
<tbody>
<tr>
<td>▪ The allowed height for storage areas is no less than 7.5 m.</td>
<td>☐</td>
<td>☐</td>
<td></td>
</tr>
<tr>
<td>▪ The maximum allowed height for warehouse areas in the storehouse does not exceed 30 m.</td>
<td>☐</td>
<td>☐</td>
<td></td>
</tr>
</tbody>
</table>

#### Comply with the following conditions in loading and unloading areas

<table>
<thead>
<tr>
<th>Description</th>
<th>Yes</th>
<th>No</th>
<th>Not required</th>
</tr>
</thead>
<tbody>
<tr>
<td>▪ Design conditions for vertical loading - back loading bays</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>▪ The width of the vertical back loading bay is no less than 4.5 m.</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>▪ There must be a distance of 5 m to move forward if the width of the loading bay is less than 3.5 m.</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>▪ The width of cross docks is no less than 4 m.</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>▪ The minimum required area for truck movement, maneuvering and circulation is no less than (35 m).</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
</tbody>
</table>
- Design conditions for vertical loading bays - lateral loading
  - The width of vertical loading bay - lateral loading is no less than 7 m.
  - The minimum required area for truck movement, maneuvering and circulation is no less than 37.5 m.

- Design conditions for 45° diagonal loading bays - back loading
  - The width of 45° diagonal loading bay - back load is no less than 3.5 m
  - The minimum required area for truck, maneuvering and circulation movement is no less than 18 m.

- Design conditions for shared loading docks

Compliance of submitted designs with figures 26 and 27

Compliance of the site landscape and parking
- Provide parking for cars of employees and workers so that they are as close as possible to the entrance of the administrative building
- Provide parking for trucks while taking into account their traffic schedule
- Provide trees for truck parking in order to improve general aspect
- Improve design the landscape and pay attention to the factory’s facade
Conditions for Different Types of Warehouses
# Chapter 5: Conditions for Different Types of Warehouses

## 5.1 Cold Warehouses
- **Introduction**
- **Cold Warehouse Types**
- **Cold Warehouse Conditions**
- **Environmental Conditions**

## 5.2 Controlled Humidity Warehousing
- **CO2 rate control**
- **Anti-Leakage Methods Used in the Established Warehouses**
- **Transform Existing Public Warehouses into Humidity-Free Warehouses**

## 5.3 Shed Storage Spaces
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- **Service Elements for Shed Storage Areas**
- **Storage Spaces:**
- **Shed Storage-related Conditions**
- **Security and Safety Requirements**

## 5.4 Open Storage Spaces
- **Surface Levelling Requirements**
- **Levelling Requirements**
- **Vehicle Traffic Volume and Pattern**
- **Weight Requirements**
- **Paths and Aisle Planning**

## 5.5 Flammable/ Hazardous Material Warehouses
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- **Material Separation**
- **Relation to Other Buildings**
- **Shared Warehouses (shed storage spaces and hazardous/ flammable materials warehouses)**
- **Environmental Conditions**
Cold Warehouses

Introduction

Cold warehouses are facilities designed to preserve the quality of foods, food supplies, biomedical materials and perishable manufactured substances that need cooling. These facilities include cooling and freezing places, mechanized areas that can include inspection and equipment facilities. This type of warehouses can be used as production, wholesale, distribution or retail warehouses.

The warehouse building is often designed in one floor, and the storage areas are composed of one single room or divided into several rooms depending on the required sizes. All cool rooms are usually operated at the same temperature. Most warehouses (except ready-made small ones) work at a higher level than the surrounding area, and are equipped with a special loading slope on one or more slide, so that the loading slope level complies with the height of most used vehicles.

Cold Warehouse Types

Stores with Unit Coolers - Single or multiple

Warehouses with unit coolers are the most used in modern cold warehouses. This is performed by fixing unit coolers with fans that have good air flow properties. This type of cold warehouses is characterized by a low installment cost, as it contains a relatively small percentage of cooling gas, and the frost can be easily removed from it without contradicting storage circumstances, and does not need big structural requirements to be met. But it is required to respect the distribution of air regularly within the warehouse, as a lot of designs that use this type suffer from bad air distribution inside the warehouse, leading to inadequate circumstances, as the air circulation movement is either too high or too low (figure 53).

It is possible to achieve regular air distribution by fixing unit coolers to the ceiling (figure 54) or fixing the unit outside the warehouse (figure 55) and making sure that the goods pallet is accumulated with vertical heights and adequate floor distances.

It is worth mentioning that the use of multiple unit coolers in cold warehouses is better than using big central unit coolers for several reasons, namely:

Figure 47: Unequal air distribution in storage area of unit cooler with one fan

Figure 48: Regular air distribution
This system gives flexibility in the case of malfunction or defect in some of the units.
The warehouse is allowed to function normally without the need to operate all units, provided that no extra high cooling loads are imposed due to products or repeated entry or exit from the warehouse.
It is allowed to remove the frost for each unit gradually, which reduces the impact on storage circumstances.
If the system used to remove frost is hot gas, the multiple unit system is necessary so that the used units provide the required cooling load for the cooling compressor.

In small units, electrical frost removal is the most common.
Frost removal in unit coolers in small cold warehouses is automatic, and is operated with a timer. With this operation pattern, it is necessary to arrange a schedule for frost removal to coincide with times where cooling load is low, usually at night.

Pre-Fabricated Cold Warehouses

In this type of cold warehouses, near used boards and structural components, there is a set of available equipment in the market to build small units in cold warehouses. Most complete equipment include wall and ceiling boards, loading slope, covers as well as cold station.
For this type of warehouses a typical example is a cold warehouse with a nominal storage capacity of 200 tons, with the measurements of 12 x 12 x 6m, constructed with isolating and supporting Polyutherane boards that are covered from the inside and outside with galvanized steel and plastic plates, as well as pre-fabricated floor.
It is required to provide cement floor in the location of the building.
The process of collecting pre-fabricated part for the cold warehouse lasts between 4 and 8 weeks depending on the local circumstances.
Cold Warehouse Conditions

Among the elements that must be taken into account when working on designs of cold warehouses: the location of engine rooms and cooling equipment. The engine room must be located as close as possible to the air cooling equipment location inside the warehouse, which impedes further extension. Therefore, they can be placed at the end of the cold warehouse, in a location that easily serves future expansion. Consequently, the engine room can be placed far from the cold warehouse building, and the air is cooled through a bridge of pipes, which gives flexibility for expansions in different directions.

Floors

- The warehouse's floor is one level, in order to prevent the use of slopes or stairs. The thickness of the floor differs according to the thickness of the isolating substance.
- The floor's level must be at the sewage level.
- Inclinations in the floor are not allowed to orient flow towards the sewage, so that the inclination does not contradict the work of handling equipment.

Doors and Windows

- Windows are not allowed in the storage area.
- Reinforced glass with metal wires is used in offices, equipment rooms, restrooms and changing rooms.
- Doors that open in both directions from the inside and outside are used.

Isolation

The structural entities, mechanized equipment and low-temperature cold pipes are isolated, in addition to a set of additional factors to ensure the safety of isolation, according to the requirements of the Saudi Civil Defense requirements for fire delay and smoke emission factors.

Mechanical protection for isolation system

External finishing materials are used while taking into account important and isolating factors such as:

- Use chemically appropriate substances that can be placed on internal roofs
- Comply with fire delay and smoke emission factors for used substances in internal roofs.
- Water entry is not allowed directly during the washing process.

External Finishing Materials

External roofs must be designed so that the building is able to withstand climate corrosive factors. External finishing materials are resistant to fire, water and do not allow the entrance of insects.

Internal Finishing Materials

It is not allowed to use any internal finishing material that might cause pollution to the stored products. All health conditions and regulations that are adopted in warehouses by the General Authority for the Food and Drug Administration must be respected. The appearance of internal finishing materials is secondary compared to their functional requirements.
Anti-Steam Barriers

- Anti-steam barriers are used with each isolating process in cold warehouses in order to protect them. An anti-steam barrier must be provided in the warm side of the isolating material and must be covered for protection against damage.

- Anti-steam isolating systems are capable of withstanding expansion and contraction in any direction, while increasing temperature, air or steam leakage. There must be a permeance of more than 0.1 Perm, whereas the expected lifecycle is no less than 25 years.

- It is particularly important to comply with the cold warehouse designs in wet climates since steam can cause serious problems.

- Anti-steam barriers are inclusive, covering all walls, the external roof, the internal ceiling and the floors. They are also used in constructed warehouses that are adjacent to the building’s wall. This is done by adding two layers at least of an adequate isolating material.

- It is possible to equip the warehouse’s door openings with an internal curtain made of interlocked strips that are made of adequate industrial substances at low temperatures (figure 37). This largely reduces air exchange without impeding passage movement. They must be maintained in good condition, as is the case with air curtains. They must also not be misused by leaving the main external door open.

- Large warehouses are equipped with large doors that can be quickly opened and closed, and are usually equipped with automated sensors or keys hanging on the inside and outside. This system is considered effective, since the door is opened for the least time possible.

Figure 51: Internal curtain composed of flexible strips that are used to reduce quantity of exchanged air

Stabilizers, Sealants and Adhesives

- Materials used to stabilize isolating substances must not influence the safety of the anti-steam barrier. Adhesives and sealants with many layers must not be used to form a barrier that might lead to an internal intensification process and form a layer of frost. Also to be avoided is the use of metal screws as a method for stabilization.

Door Heaters

- They are used as needed in order to avoid humidity and frost accumulation on the sides. The air curtain distribution on the sides of doors between cold areas at different temperatures must be reconsidered.
Special Equipment for Cold Warehouse

- Hydraulic, mechanical and electrical modifications for trucks, that are used in cold warehouses include two categories:
  - First category: Special condensation protection, implemented on trucks operating in a temperature-changing environment inside the warehouse.
  - Second category: includes battery heaters, hydraulic system modifications, and condensation protection. Implemented on trucks that work in an environment of changing temperature inside the warehouse. Temperatures vary between a regular one and -40°, or when operations are continuous, temperatures vary between 0° and -29°.

Alarm systems

- Cold warehouse facilities must be equipped with alarm and security systems and high temperatures.
- Each room must be connected with an alarm system outside the room and observed 24/7. Assistance is provided in the room if needed.
- When warehouses are equipped with security systems, alarm systems are used to alert in case of any unauthorized entrance inside the building or the individual storage rooms.
- Thermal alarm systems that are used to alert to any damage in the cooling systems or any increase in temperature in cold areas, within cold areas or in delivery and shipping offices. All cooling devices are represented by a control and alarm system board and disjunction keys in each of the warehouse’s rooms.
- A water sprinkler is installed in all storage, operation and equipment areas.

Water Sewage

Used in periodic cleaning operations. No water sewages are allowed within storage aisles, in order to keep an even floor within aisles. Water sewage deviations are designed under racks and not in storage aisles.

Electrical System Requirements:

- Electrical system requirements are summed up as following:
  - Provide protected steam-resistant lighting installations in all cold areas.
  - Provide an adequate lighting level in cold areas at a level of 107.6 Lux at a height of 1.2 m.
  - Provide electrical energy exits that meet the following criteria:
    a. Operate automatic doors.
    b. Cooling equipment.
    c. Ship batteries for handling material.
    d. Thermal alarm systems in case of temperature increase in cold spaces.

Inspection Room

Built for large activities, allowing a veterinarian to inspect goods (laboratory + office) with a forklift truck.

Storage Area Lift

The warehouse’s elevation is designed to achieve optimal economic benefit of storage loads. In case of ground floor storing, the height of loads must not exceed 4.88 m.

Width of Storage Load Aisles

Cold warehouses are designed so that the width of storage aisles does not exceed 2.4 m. Special forklifts are used in tight aisles in order to reduce the width of aisles.
Stabilization of Racks

Racks are stabilized on the floor, and are not allowed to be fixed on walls or ceilings. An additional stabilization can be provided by using cross racks.

Environmental Conditions

In addition to the conditions mentioned in Chapter 1, the following conditions are specifically applied for cold warehouses:

- In case of presence of freezers inside the warehouse, they must not be directly exposed to sunlight.
- Cooling and freezing storage rooms are equipped with highly-efficient cooling and freezing devices and thermal measurement devices with the ability to read the results from outside the room.
- A list must be placed on the warehouse's door showing the quality and expiry date of stored food products.
- All food products must be stored at an adequate temperature, either at the cold room's temperature of $4^\circ C$ or at a freezing temperature of $-18^\circ C$.
- All food products must be adequately placed in the storehouse (like hanging frozen or cold carcasses).
- All food products must be organized so that they can be accessed from all the warehouse's parts, in non-accumulated organized queues and at adequate heights for better access.
- There must be enough distance between the stored products for air circulation so that it covers the highest distance possible.
- Products with pungent odors must be stored in special places.
- There must be no contact between food products and the warehouse's walls.
- It is strictly prohibited to store house detergents and insecticides in food warehouses.
- Food cans must be organized in a way that makes it easy to read labels on them.
- Cans must be organized from oldest to newest (FIFO$^9$)
- In case of using mobile mechanical conveyors to and load transport food products inside the warehouse, they must not use diesel as fuel.
- All workers in food warehouses must have valid health degrees that prove they do not have any infectious diseases.
- Complete attention to workers’ health.
- Workers must wear a unified clean uniform during work, and it must protect them from cold in case of entering freezing warehouses. They must wear special sanitized and clean shoes to enter warehouses. Shoes are kept in special bins. It is strictly forbidden to enter with regular shoes.
- Any worker that shows ill symptoms or that shows blisters, wounds or skin ulcers, or appeared to have had a contact with a patient of an infectious disease must be kept away. The manager of the warehouse must report to the competent health authorities in case any worker showed symptoms of infectious diseases.
- The competent authorities are allowed to exclude any worker they consider a hazard to public health.

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9. First In First Out.
5.2 Controlled Humidity Warehousing

Humidity penetrating warehouse buildings and storage facilities, when adopting a natural ventilation system or in case of presence of small gaps in the building structure, may lead to high-cost and destroying damages that may impact stored goods and materials in facilities such as iron, detergents, timber, paper, cardboards, paper, salt and textiles, and others.

Therefore, there’s a type of warehouses designed to be completely isolated to process the steam pressure and treat and control the humidity causes. Many systems exist to withdraw humidity and criteria through which the proper system is selected.

CO2 rate control

External ventilation should be provided in humidity-free warehouse buildings where liquid-oil-operating equipment, and where CO2 concentration in the air exceeds the acceptable rate of 50 (particle in 1,000,000 air particles). Therefore it is recommended to use transport battery-operating equipment that function, when possible.

Anti-Leakage Methods Used in the Established Warehouses

When starting to design limited humidity warehouse buildings, anti-leakage methods and materials should be used as the following:

- Use of material-and-power-permeable steam barriers (Permeance) equivalent to 0.1 Perm or less, to be placed on a barrier made of soft stones, finished with a straight surface and placed on a concrete floor.

- Walls are not isolated, however external exposed walls are to be double painted with water paint that can be replaced with a 3 mm-layer spray process of cement.

- All connections in the previously formed concrete building shall be hermetically closed

- External intersections between walls and ceilings shall be hermetically closed

- Anti-steam barriers shall be provided on ceilings

- The design of fire-resistant doors shall take into consideration full separation between humid and dry surfaces

Transform Existing Public Warehouses into Humidity-Free Warehouses

There’s a number of requirements that should be applied on walls and ceilings to transform this type of facilities:

- Remove all upper air conditioners and hermetically close gaps and windows, ensuring all doors comply with structural specifications

- The warehouse existing doors should be provided with hems, and hermetically closed

- Stop using cargo doors and hermetically close them
5.3 Shed Storage Spaces

These places consist of roofed/shed storage decks that have neither sides nor walls (canopies), and have full elevation. All kinds of service utilities are provided for this type of warehouses such as water, power, natural gas in addition to workforce requirements and fire prevention. This type of warehouses is used to store materials requiring maximum ventilation, or materials not requiring full protection of weather conditions. Their location can be determined following the function identified and the surrounding conditions of the site.

Shed Storage Location Types

There are several types of shed storage locations or canopies namely:

- **General Purpose Shed:** where the minimum service utilities such as power plugs to operate power-functioning devices, and basic lighting equipment are provided

- **Transitory Shed:** temporary deck consisting of pre-fabricated dismountable structures that can be recollected to be relocated. This deck can be placed on a reinforced concrete-made panel

- **Flammable/ Hazardous Materials Shed:** this is where gas cylinders and hazardous material barrels are stored. This type of shed is provided with ceiling-hung fans and upper water fire-fighting sprinklers.

Service Elements for Shed Storage Areas

They consist of available amenity services provided so as to be adjacent to the storage area, mainly including office and restroom-dedicated spaces as part of the space determined for the storage area. These elements are distributed as the following:

- **Supervision Office:** the location of which shall be within the covered warehouse where the maximum of interaction is provided with the shaded area, staff services, operations area, car parkings and other services

- **Staff Services:** These services are based on the required number of employees and workers, and on the interaction with warehouse-support systems. Among these services: changing rooms and restrooms that vary in terms of area and extent. In addition to these services a covered area should be provided having a moderate temperature that is in line with the various prevailing weather conditions, whether hot, humid or cold area.

- **Additional Services:** that should be provided as needed, such as the inspection, classification and staging room, parking, truck and vehicle maintenance areas, in addition to other service elements that should be provided in covered warehouses.
Storage Spaces:

Storage spaces are divided into main areas through which materials are separated one from the other for further security and safety. There are two types of shed storage surfaces: Enhanced surfaces and semi-enhanced surfaces that should be provided with the proper materials, so as to ensure the adequate capacity to carry various loads and control water drainage.

a. Treated Surfaces: Impermeable surface requiring careful attention regarding water draining requirement and streams

- Portland Cement Concrete: Concrete surfaces providing a solid basis for heavy weights. Cement can be used when traffic is intensive or when impermeable surfaces are required to be in line with oil leakage risks

- Asphaltic cement surfaces similar to Portland Cement Concrete, with a lower cement strength

b. Partially treated surfaces are not recommended for shed storage unless the structural building is considered temporary

Shed Storage-related Conditions

1. The canopy form and dimensions are determined by the project and site requirements, where the length to the width ratio should not exceed 3:1 in case of existence of filled gas. The length could reach 183 m in case storage canopies were dedicated for vehicle and truck storage.

2. Accessibility: should be provided from all sides in case the stock consists of hazardous contents, in a way to be open from all sides or from one side only; and should be designed for cars to store construction materials. Entry point requirements are to be identified in line with the site and the function dedicated to this type of storage.

3. Water Drainage: for the shed area and the neighbouring open areas to protect the structural structure safety of the storage surface and prevent water flow when weather conditions deteriorate

4. Vital Facilities: These are the basic utilities that should be provided such as drinking water, wastewater, power facilities, as needed, for lighting and fire fighting purposes

5. There might be a need for water to carry on cleaning operations for stored materials devices upon delivery or shipping, and to clean storage/ handling devices. Cleaning water may become polluted with petroleum products; in that case water should be contained and handled in a specific way.

6. There might be a need for electric power for devices used in staging processes in storing areas or any process required by dedicated devices in storing/ handling operations

7. The need for internal and external telecommunication system shall be assessed based on the establishment planning, size and site.
Security and Safety Requirements

Materials or devices stored in shed areas require a series of prevention measures as the following:

1. Provide adequate walls in line with urban requirements (kindly refer to the Warehouse Construction Conditions Chapter)

2. Provide lighting from (5-10) lux in open areas surrounding the shed areas, with the possibility to increase lighting intensity to meet security requirement when needed.

3. Covered storage areas design elements should be assessed in light of the natural factors such as solar movement across the year, the wind direction, and precipitation.

4. Storing humidity and high temperature-sensitive devices and materials requires the use of special packing materials and periodic inspection operations.

5. Provide systems to contain leakage occurring outside shed storage areas due to stored barrels, by providing an exit in docks (slope) that allow the access of material handling devices and firefighting vehicles, so as to be able to contain as much as possible the leakage equivalent to 10% the size of the stored liquids.

6. Provide upper water sprinklers similar to sprinklers used in covered warehouses. Similarly, all doors leading to neighbouring buildings are equipped with water pipes or anti-water flow barriers.

7. Shed storage areas should be separated from hazardous material storage areas in neighbouring warehouses through a 4 hour-fire-resistant wall designed to have holes in it. Place these walls between the stored gas cylinders and hazardous content barrels.

8. The upper part of the wall shall remain open with a distance of not less than 91.5 cm.
5.4 Open Storage Spaces

Open Storage Places are a type of warehouses used to store goods that do not require comprehensive protection. These places are either treated, partially treated or semi-treated and do not require the provision of any cover to the stored materials. Entrances applicable for general warehouses are provided as all the required service facilities should be provided to receive and load goods.

- **Treated Areas**: these areas are thought to be the most flexible areas used to store goods, as the site is surveyed to check for the vegetation and ground gradient, and is provided with the appropriate wastewater system, then treated to become a solid surface. This area allows the storage of a number of elements that cannot be stored in untreated areas due to the increased tolerance capacity and a high control capacity on surface flow. Materials used for land levelling, are the concrete panel and the asphaltic paving among others. Crushed and levelled pebbles are also used, however it is less adequate for having lower capacity to resist loads.

- **Partially Treated Areas**: These areas are very similar to treated areas in terms of land levelling and water drainage; no solid ground is available for these areas such as in enhanced areas

- **Untreated Areas**: These areas were not subject to any land leveling or water drainage process and are not covered with land solidification materials, in this case they can be classified as untreated. Ground lines do not allow goods storage with heterogeneous elevations. When the ground is not leveled and is not provided with water drainage, some collected water areas may emerge which would weaken the soil, making these areas among the unpreferred areas for goods storage, ie. among open areas for not having intensive capacity to store and easily enter storage areas.

**Surface Levelling Requirements**

Paving Type Selection depends on factors that affect open and treated surface paving requirements, including: vehicle specifications, traffic volume and traffic flow pattern, material accessibility, and stored material weight requirements.

The types of surfaces used recurrently for treated storage areas are: solid paving and concrete paving (Roller Compacted Concrete Pavements RCCP). And selecting a pavement type is closely linked to the use of requirements mentioned above.

The solid paving can be applied where long-term permanent concrete panels are used, as they are capable of resisting large loads and are not affected by the natural fluctuation of temperature degrees across the year. The type of pavement does not require high workforce in terms of production; and this method is often the mostly used land levelling method.
Levelling Requirements
The levelling thickness and load is determined by the driving wheel load, the number and the setting of wheels in each vehicle, the wheels contact pressure and contact area. And given the various paving requirements, the effort made in the construction and the maintenance could be bigger to a large extent than any vehicle with an equal loading capacity.

Vehicle Traffic Volume and Pattern
The traffic volume is a key consideration based on which the land levelling and the related thickness will be selected, it is necessary to conduct a comprehensive study showing the number of trips and traffic operational patterns of all vehicles. Choosing the stored materials affects the selection of the type and thickness of pavement.

Weight Requirements
The pavement loading capacity is mainly determined by the elevation and the extent available to stock goods, or the maximum load that can be unloaded on a specific area. The pavement type and thickness depends on the storage requirements, whereby the temperature in the summer may affect most flexible pavement surfaces. In addition, a bad execution of the foundation or part of the foundation may lead to lowering the paved surfaces given the weight of the loads.

Paths and Aisle Planning
Open storage areas require experts capable of providing plans appropriate for storage aisles and circulation paths of the materials to be stored in a specific area. Generally, the type of material stored in addition to delivery and handling equipment impose specific dimensions that need to be used when moving materials. And having movement aisle plans in open storage areas provide straight storage circulation paths in loading and unloading areas. These plans also provide easy access to any storage area, and ensure maximum efficiency in terms of service utilities use of these paths. Storage paths in open areas are a type of road given the large dimensions of mechanical delivery and handling equipment available. Therefore, key storage corridors should be placed in a linear direction of the storage area, while lateral circulation corridors are perpendicular with main corridors, where the actual storage area takes a rectangular form. Main aisles should be in large open storage areas, to be equipped by rotation with a double aisle that accommodates vehicles that can load goods on one aisle.

Figure 52: Illustrative example of open storage spaces
Open Storage Spaces

Conditions for Different Types of Warehouses

Figure 53: Lateral loading platforms

Figure 54: Back loading platforms
5.5 Flammable/ Hazardous Material Warehouses

These warehouses consist of storage areas designed and built as per the standard references of hazardous or flammable materials storage that may be dangerous for the health, environment and property. They may be used to store flammable materials, acids, caustic or burning materials, oxidized materials, materials interacting with water and other materials thought to be hazardous.

Hazardous material storage facilities are designed and built so as to provide protection from material, health and environmental hazards that may result. Storing and handling these hazardous materials should be limited to premises or parts of premises that meet the requirements set in this section and to which a set of special conditions apply.

Flammable Material Warehouse Conditions

▪ The NFPA standards shall apply on the design and construction of hazardous material storage facilities

▪ Storage and processing of hazardous materials should not be made in mixed-use buildings

▪ Planning and designing warehouses should consider the possibility of incompatibility between hazardous materials, as these designs are subject to considerations that are related to the types of stored materials, each material separately. The structural design and fire control system should obtain the civil defence approval, after conducting a safety analysis on the system and as per the civil defence requirements.

▪ The storage requirements should be considered when designing hazardous/ flammable material warehouses as the following:

a. The storage area is to be designed so as to prevent surface or underground pollution in case of leakage, placing each category of materials in a total separate place

b. When storing acids or liquid caustic materials, a vehicle where the driver’s seat is elevated should be used, or liquids should be stored on the floor for them to be stored within the vision level of the operator.

▪ Power-operating material transportation equipment is the unique type of equipment allowed to be used in flammable and hazardous material storage areas. In this case Electrical Equipment (EE) are used whereby all electrical devices are completely turned off. The use of EX-type vehicles designed and assembled to be used where there’s steam, dust and flammable fibres might be required while checking the need for any additional requirements that may be imposed by specific storage conditions.

Material Separation

▪ Provide separated storage areas for materials with incompatible hazardous specifications. There are six flammable/ hazardous categories of materials that must be accommodated in separated storage areas provided within the flammable/ hazardous material storage premise. There are other categories that could be found in some designs and that require additional separated storage areas, and composed of the following:
Flammable and Combustible Liquids

- Liquids are identified as per NFPA code 30, the same as any other matter with liquidity exceeding 300 degrees to penetrate asphalt, when testing them as per the asphaltic material penetration test.
- Flammable liquids having a flash point of less than 38 degrees, and a steam pressure that does not exceed 275 (kilopascal) in 38°C.
- Flammable liquids have a flash point of 38 °C or above.

Acids

Acids, acidic fog, gas with arsenides, borides, carbides, cyanides, fluorides, phosphides, selenides, silicides, sulfides, sulfate, tiliorides interact to generate poisonous vapors. These materials liberate hydrogen when in contact with metals and hydrides.

Oxides

Oxidized materials are solvable chemical materials under specific conditions to produce oxygen. These materials may generate fire when in contact with flammable materials and highly interact with water when in a fire. Typical oxides include the following organic and non-organic peroxides, permanganates, chlorate, perchlorate, sulphates, organic and non-organic nitrate, bromates and ultrabromate, chromate and bichromate.

Toxins

Toxins are materials causing poisoning- caused death through the respiratory system. In unfavorable conditions such as spill, leakage, fire or mis-ventilation, some materials or common chemical compounds such as ammoniac are considered toxic.

Water-interacting materials

These materials interact with water and steam or with water solutions to produce flammable gas, toxic gas, explosive gas and heat. Flammable gas-producing materials include calcium, cobalt, hydrides, lithium, potassium, rubidium and sodium bullion. And explosive gas-producing materials include arsenides, borides, nitrides, phosphides, carbides, selenides, silicides, sulfides, and tiliorides. As for heat- producing materials, they include non-water acids, concentrated acids and concentrated alkalies. It is necessary not to use water-based firefighting systems in water-interacting material storage areas. In this case carbon dioxide or halon fire extinguishers would be acceptable.

Caustic or Burning Materials

Caustic materials or alkalis may liberate hydrogen when contacting aluminum, as they do not comply with acids and must be isolated from acids to ensure safe and efficient operations.

Organic Peroxides

Organic peroxides should be stored in separated warehouses, totally isolated from other materials.

Separation Requirements

The following separation requirements shall be provided in hazardous material warehouses:

a. Acids must be isolated from other materials, including chemical materials inside erosion-causing material area
b. Isolate flammable liquids from acids and oxides
b. Isolate organic acids from oxides
d. Isolate oxides from all flammable and combustible liquids
Barrel-packed petroleum, oil and lubricant products

Barrel-packed petroleum products, oils, and lubricants with a flashing point exceeding 38 °C can be stored in a level higher than the ground floor (mezzanine) or in open storage facilities with hermetic dockings and sand bags/ dams or ponds to contain any accidental leakage. Filled petroleum, oil and lubricant products can be stored in outdoor warehouse, provided that barrels are made of erosion-resistant or thermally galvanized materials to remain protected from erosion.

Other materials

Dry erosion-causing and other materials that are subject to control, in addition to radioactive materials with no other hazardous effects, can be stored in public warehouses. Other radioactive materials should be stored in specific and separated areas.

Relation to Other Buildings

- When indicating site requirements, neighbouring buildings and potential exposure to hazardous materials is to be taken into consideration
- A buffer area of at least 15.2 m should be taken into consideration between the warehouse and the nearest residential area, stream or water surface
- Fire sector in flammable liquid and other hazardous material warehouses should not exceed 1858 m
- Flammable/ hazardous material warehouse building elevations should not exceed 7.6 m

Tight Gas Cylinder

Tight gas cylinders are to be stored for flammable and non-flammable gas, and for gas classified as oxides in level higher than the ground floor (mezzanine) and not in flammable/hazardous material warehouses. Small cylinders placed in trunks and forming an integral part of other equipment can be stored in flammable/hazardous warehouses, if not properly separated from non-compliant materials.

Figure 55: Plan showing how to isolate hazardous and non-hazardous materials.
Shared Warehouses (shed storage spaces and hazardous/ flammable materials warehouses)

- When hazardous/ flammable material warehouses are combined with shed storage spaces, a 4 hour-lasting fire-resistant wall should be provided to separate between both storage areas. The warehouse and shaded area ground level is to be the same, while providing drainage channels to contain accidental leakage. Accessing the roof should be from the warehouse basin rather than the storage area.

- **Construction:** ceiling materials should be indicated as being thermal-expansion and torsion resistant to avoid the ceiling destruction in case of fire (table 11)

- **Structural elements:** structural elements shall not be combustible

- **Fire-resistant walls:** providing 4-hour-lasting fire-resistant walls to separate non-compliant storage areas from other uses and contain fire areas. Outer walls may be classified as 2-hour-lasting walls.

- **Doors:** fire resistant doors, either rolling or sliding, should be made of steel. Whenever possible, it would be better to avoid having doors on fire-resistant walls, metallic doors are to be provided for staff.

- **Explosion release:** in storage areas classified as separated rooms or annexed buildings, and where class 1-A (NFPA-30) liquids are stored in 3.79 L containers, the wall or the outer surface is to be designed for the explosion release, such as low-weight walls and ceilings with roof-hole or windows to release explosions. NFPA 68 standards are used and they include requirements for those two types of warehouses.

- **Floor:** a non-absorbable, non-slippery acid-and-erosion resistant wrapping layer is to be used for all storage area floors and flammable material warehouses.

- **Washrooms and eyes washing stations:** emergency restrooms and eye washing stations are provided within 30.5 m of the areas exposed to potential leakage within the facilities.

- **Ventilation:** for each storage area found in each of the hazardous material categories indicated in table 11, there's a related separated ventilation system. Controlled ventilation systems should be continuously provided, while preventing accumulation of exploding steam. The ventilation ratio should be as the following: the actual release hole to the floor distance should be at least 1:30, using roof-ventilation holes or other appropriate ways. Provide the mechanical air movement with the minimum of 6 air hourly replacements for each indoor warehouse. The ventilation system should be linked to the room lighting key, air provision and steam extraction system from the floor and the ceiling. Air streams, fans and other parts of the system used to release erosion-causing materials from the erosion-resistant building.

[Figure 56: Illustrative section of a fire-resistant material warehouse]
Table 11:

<table>
<thead>
<tr>
<th>Site</th>
<th>Requirement</th>
<th>Electric Requirement</th>
<th>Construction Material</th>
<th>Fire Protection</th>
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<tr>
<td></td>
<td>Site</td>
<td>Explosion Resistant</td>
<td>Erosion Resistant</td>
<td>Fire resistance</td>
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<td>Other controlled materials</td>
<td>Negative pressure</td>
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</tr>
</tbody>
</table>

- **Protection from lightning strikes**: protecting structures from lightning strikes as per NFPA 78
- **Alarm devices**: provide hazardous chemical material storage areas with alarm devices indicating leakage or spill of stored chemical materials
- **Contain and control spills**: ways should be provided to contain and eliminate spill, when relevant
- **Basins**: basins are used to contain spills of stored goods or those handled outside the buildings.

And as per NFPA 30 standards, the basin should at least have the size of the largest quantity of liquids that could be released of the largest storage container within the area surrounding the pond.

- **Ground trenches and containment systems**: a ground trench with a grid barrier is to be used at each entrance to contain and control hazardous chemical spills. All spill-containment systems ensure containment through fixing channels supporting the grid frame on a concrete floor.
The grid design provide the capacity to lock liftable interlinked sections in aisles and shipping doors to ensure that grids remain in place when moving material transportation equipment above them. The cross-section of the parts forming the grid frame should take a “Z” letter form rather than “L,” and placed in a way that both the letter “Z” legs form the grid pocket and the third leg remain horizontally at the floor level, as shown in figure 35. This aims at protecting the cement borders around the grid frames from the damage that may occur from material transportation vehicle wheels.

Electronic-guiding cabling: when an underground electronic-guiding cable is used to guide materials transportation vehicles through trench grids passing through aisles or shipping doors, non-magnetic bar sections are used extending for at least 6 inches (150 m) at each side of the cable path, in a way that does not harm the magnetic field of the guiding cable by inserting cables through iron or magnetic bars. Or otherwise, open drainage channels are used and the guiding cable is used below them, covering the guiding cables through iron or magnetic bars or drainage channels.

Staff exits: staff exit door should be lifted 6 inches (150 mm) above the floor to avoid the leakage of spilled liquids. Where the trench passes next to staff exit door, steel panels are to be used instead of the grid to avoid any fire in the trench leading to the blocking of the exit door.

Floor setbacks: when needed, and for specific design purposes, or for containment purposes, internal storage floor surface setbacks should be of at least 6 inches (150 mm) below the warehouse basin, neighboring back-office or areas to prevent the flow of hazardous liquids spilled in these areas. Across these areas, slopes must be provided at the entrance of vehicles. This method is not encouraged for not being operationally efficient, and for the resulting additional surface requirements of the mentioned slope.

Containment: Use of grid-covered internal gutters with 350 gallon capacity (1323 L) in addition to a trench system ensuring spill or leakage containment for less than 1000 gallon (3785 L) or 10% of the total spilled liquid.

Figure 57: Illustrative plan of the drainage system
across all container in each room. Provide a containment capacity of 1000 gallon (3785 L) in the truck path adjacent to the shipping and receiving area. Introduce a controlled flow system to block the entry of spilled or leaked materials to the stormwater drainage system, stream or any other water body.

- **Drainage:** establish platform shelves (palette goods) and the related mechanic vehicle guiding systems to ensure smooth flow of leaked liquids to collection trenches. Preserve floor surfacing requirements. Floor gutters should not be established in storage areas in flammable/hazardous warehouses.

- **Immediate firefighting systems:** provide all areas with immediate firefighting systems.

- **Design requirements:** the system design should meet the low-expansion foam system and compound mediums criteria requirements, namely: NFPA 11, NFPA 12, NFPA 13, NFPA 30, NFPA 231, NFPA 231 C, CFR 29 and section 1910.

- The demand on sprinkler water is based on a hydraulic system design. Sprinkler nozzles must be appropriately chosen to be placed in erosion-causing environment. Water-interacting material storage areas are protected by providing them with a 1310 Bromotrifluoromethane or carbon dioxide-based firefighting system (halon). When using dry system (without using water), loud alarm devices must be provided operating 30 seconds before activating the system. The automatic alert of the local firefighting management should be provided when activating the system.

- **Sprinkler control:** control to indicate sprinkler sites through the use of the striated mechanic pipes rather than the geared pipeline accessories as shown in figure 21. Please call the maritime project NAVSUP to use the warehouses for guidance on specific applications.

---

**Environmental Conditions**

In addition to the conditions mentioned in chapter one, the following conditions apply on flammable/hazardous material storehouses.

**Flammable Material Storage Conditions:**

- The storehouse should be equipped with firefighting devices and equipment that are adequate to the allocated space and the nature of stored materials. Chemical material storehouses are to be equipped with an immediate firefighting system given the high risk.

- Doors and holes available at joints should be fire-resistant and should permanently remain locked, or to be of the automatically-closing type when a fire occurs not to be a way for the fire to spread.

- A periodic inspection should be conducted on electric structures and equipment to ensure safety and prevent the occurrence of any electric damage as a result of the warehouse extended electrical structure malfunction.

- A periodic maintenance for devices and firefighting equipment available in the warehouse should be conducted. These should be hanging in an accessible place.
The size of the container and charge should not exceed the acceptable limit, which indicates the capacity and chemical material flammability.

Flammable liquids such as gasoline, fuel oil, dyes and others, should be stored in special containers and marked in writing to indicate the content and the flammability. These containers should be stored in areas specially designed and allocated for this purpose.

Appropriate chillers should be used to store volatile material.

The need to provide and use safe lighting for electric devices and pipelines to be fire-resistant and avoid the occurrence of electric spark that could lead to a fire within stored materials.

Containers should be provided in large charge storage areas, with not less than 15 cm high to contain liquids in case of spilling, taking into consideration not to fully fill charges.

Guidelines should be indicated on how to use firefighting equipment and how to behave in case of fire, what path to take and how to evacuate in case of emergency. These guidelines should be placed in an apparent place until easily recognized and memorized.

Safety data are preferably to be provided (MSDS10) for each product available in the warehouse.

Solvents and Toxic Material Storage Conditions

- Solvents and toxic materials should be stored in special containers marked in writing to indicate the name of the material and the degree of toxicity or hazardousness, in addition to the precautions to be taken while using or handling them or even opening these containers.
- Store toxic materials in a way that prevents its spread in case of spilling or leakage, in safe areas where no one is allowed access under no circumstance.
- Chemical materials should not be exposed to direct sunlight or local heat.
- Storehouses should be provided with respiratory system protection devices, protection gloves and safety eyeglasses.
- Workers in these storehouses should get acknowledged with how to use these equipment and how to protect themselves from potential risks.
- All information and instruction indicated on container must be carefully read, while ensuring that all the written necessary precautions have been taken before moving the container from one place to another or before being handled.
- Emergency shower and eyewash-equipped places should be provided in warehouses to be used in the event of a worker using a toxic material during working hours.
Tight Gas Storage Conditions

- Cylinders should be painted differently depending on their content
- Each cylinder is marked as empty or full and should be easily identifiable
- The name of the material written inside the cylinder is to be written clearly on the cylinder body
- Oxygen cylinders should not be stored inside buildings and in the same room as Acetylene or fuel cylinder unless totally isolated from each other by a fire-resistant barrier
- Cylinders should be placed vertically and tightened with chains. It is strictly prohibited to roll or slide them horizontally, and should be moved in specially-made vehicles
- The protective cover should be placed above the cylinder valve to protect from damage
- Valves of stored cylinders should be closed, whether they’re full or empty
- No oils or lubricants should be used when tying something upon cylinders
- Flammable and toxic gases storage should be made above ground level and it is not allowed to store them in tunnels
- Interacting gases are to be separated or isolated from each other with sufficient distance
- The path to cross to arrive to the cylinders should be free of obstacles so they can be easily closed when any emergency occurs
- Staff deployed to work on tight gas, are required to be knowledgeable of storage and handling rules and the related emergency procedures.
Sustainability in Warehouses
### Chapter 6: Sustainability in Warehouses

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6.1 Introduction

Sustainability and resource conservation are currently considered the topics of the hour and their inclusion in facilities’ development, design, and management leads to savings in energy consumption and conservation of natural resources, in addition to creating a better work and life environment.

A sustainable warehouse design has the below benefits:

▪ Achieving efficiency in facilities and buildings’ design and reducing energy consumption;

▪ Rationalizing potable water consumption, thus contributing in reducing sewage water production and its treatment and transport cost;

▪ Improving buildings’ internal environment, through a series of important benefits such as better air quality, adequate internal temperature, management of sun glare and daylight, etc.;

▪ Reducing negative impact on external environment, including less harmful gas emissions and water and air pollution, and water consumption;

▪ Achieving higher revenue on the medium and long term by reducing costs of energy and other resources and of buildings maintenance and operation, while also providing better production environment in warehouses thanks to a better internal environment for workers.

MODON encourages owners and investors to take sustainability seriously though incorporating sustainability principles in design and development of industrial facilities, and respecting recommended standards and requirements.
6.2 Material Resources Efficiency

MODON encourages developers, investors, and contractors working in industrial cities to provide ways and solutions for reducing garbage production, starting from design of the factory and subsidiary facilities, to provision of assigned spaces for waste collection and sorting once the operation starts, as well as during construction process, and finally during the warehouse operation as shown in the below figure.

<table>
<thead>
<tr>
<th>Design</th>
<th>Construction</th>
<th>Operation</th>
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<tbody>
<tr>
<td><img src="image" alt="Design" /></td>
<td><img src="image" alt="Construction" /></td>
<td><img src="image" alt="Operation" /></td>
</tr>
</tbody>
</table>

Reduce waste in design stage through:
- Off-site manufacturing
- Standard components
- Provision of spaces for recyclable materials

Reduce waste when building warehouses and subsidiary facilities through:
- Waste management plan
- Waste production reduction
- Waste sorting
- Recycling

Reduce waste when operating warehouses and subsidiary facilities through:
- Waste collection and sorting
- Recycling
Within this framework, MODON advises consultants to conduct studies and present suggestions to reduce environmental impact.

- When designing warehouses, MODON recommends off-site fabrication to reduce waste production during construction works waste, with building components being produced off-site in specialized factories and then transported on site for assembly. This system is very common and is often used for building facades and rooftops, especially for metal buildings, and can be easily adapted to warehouses.

As for during the construction stage, contractors are encouraged to prepare a waste management plan to reduce waste production and increase recycling on-site as it has many benefits, including:

- Reducing on-site waste production
- Reducing on-site construction time
- Reducing construction cost, and achieving better quality construction.

Finally, when starting the operation stage, production line waste, including waste water and harmful materials, must be treated in a separate way as mentioned in parts 4 and 8 of the present guideline.

In addition to the above, in order to reduce warehouse operation environmental impact, warehouse owners and workers are advised to ensure dedicated spaces for collection of recyclable waste. The total area of these spaces depends on the area of the warehouse, its facilities, type of product, and manufacturing method, noting that all elements are defined in a more detailed way by waste management and recycling experts.

<table>
<thead>
<tr>
<th>Table 12: Sample of recyclable materials</th>
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<tbody>
<tr>
<td>Offices</td>
</tr>
<tr>
<td>Paper</td>
</tr>
<tr>
<td>Cardboard</td>
</tr>
<tr>
<td>Aluminum cans</td>
</tr>
<tr>
<td>Glass bottles and cans</td>
</tr>
<tr>
<td>Plastic</td>
</tr>
<tr>
<td>Metals</td>
</tr>
</tbody>
</table>

Material Resources Efficiency
Sustainability in Warehouses
6.3 Building envelope

Walls

All external walls must include thermal insulation material which helps reducing heat gain, especially in summer. Insulator type and thickness is determined by engineers to Heat Transfer Index (U-value) equivalent to 0.2 W/m²K at most for the wall.

Effective insulators include extruded polystyrene, mineral wool, rock wool, and glass wool. Project engineers are encouraged to explore materials with high heat insulation properties in order to enhance their overall performance and reduce heat gain.

Insulated panels are among the most used insulators in warehouses and administrative buildings. They are constituted of extruded polystyrene covered from both sides by hot-dip zinc or thin aluminized steel.

These panels can be flat or undulated and can also be assembled as external walls for concrete or steel buildings.

Rooftops

All rooftops must include heat insulators to reduce heat gain, particularly in summer. Insulator type and thickness is determined by engineers to achieve a Heat Transfer Index (U-value) equivalent to 0.1 W/m²K at most.

Extruded polystyrene is considered the best insulating material for concrete rooftops, with insulated panels being the best system for steel buildings, especially factories and warehouses as they are constituted of extruded polystyrene insulator covered from both sides by hot-dip zinc or thin aluminized steel.

Polycarbonate slots are recommended for warehouse rooftops as they are light-weight, easy to install, less expensive (than glass) and have a good thermal performance. This system is constituted of multi-cell polycarbonate sheets with rough external feel (hammered glass). (These systems are known in KSA as Lexan, their main component, produced by SABIC).

It is recommended to have a thickness of 38 mm or more and a light transmission index of 55% at least for white or translucent colors with a solar heat gain coefficient of 0.55 at most.
Windows and Glass Usage Rate

Glass in walls and rooftops must be constituted of several layers of high performance glass to reduce heat gains, knowing that it is possible to use Argon gas between the different layers, as well as insulating and colored paint. It is advised to target a Heat Transfer Index (U-value) equivalent to 1.8 W/m²K at most for glass.

Polycarbonate slots are translucent multi-layer panels that allow light to go in, and are also recommended for warehouse and industrial building walls at a minimum thickness of 38mm and a light transmission index of 55% at least for white or translucent colors. The Solar Heat Gain Coefficient must be of 0.55 at most, while it is advised to target a Heat Transfer Index (U-value) equivalent to 1.65 W/m²K.
**Envelope Openings**

Openings in external building envelopes are allowed up to a certain size to avoid high heat gain and excessive heat inside the building, especially in summer. Following guidance shall be respected:

- Openings in warehouse façade shall represent 25% at most of the overall area of external walls;
- Openings in administrative building façades shall represent 40% at most of overall external wall surface;
- Openings in warehouse rooftop shall represent 15% at most of overall rooftop area.
6.4 Potable Water

Water efficient equipment must be installed in all lavatories with maximum water flow rate as follows:

- Restrooms: 1 GpF (Gallon per Flush)
- Urinal: 0.5 GpF
- Sink: 1.8 GpM (Gallon per Minute)
- Washrooms: 1.8 GpM

Several types of water-efficient plumbing equipment are currently available in local markets and include for example aerator-equipped tap that reduces water flow. It is also advised to use infrared sensor taps as well as low-flow toilets such as 3/6 liter and low-flow showers.
MODON seeks to support sustainable approaches in facilities development and management, especially when such measures have many benefits for developers on both short and long term.

In addition to this, MODON seeks to enhance performance of buildings and sustainable site elements which have been recommended in this guideline and encourages developers to follow essential procedures to achieve a sustainable development:

- Green building certification
- Production of renewable and low carbon energy.

Green Buildings Certificates

Having green building certificates from local and international rating systems adds in credibility and reflects a commitment to minimum “green buildings” elements. International ratings systems such as LEED and BREEAM award certificates to projects after a full examination of facilities’ designs against a list of green building standards for several elements such as location, energy, water, construction materials, external environment, etc.

Following MODON’s guidance will help investors and developers in securing green building certification; they will also need to implement a number of requirements related to targets and standards that need to be respected and documented through calculations, drawings, and reports to be prepared at various stages of design and construction.

In general, MODON recommends LEED system as it is one of the oldest and most used and known systems among engineers, consultants, and contracts (noting that MODON also accepts other systems such as BREEAM).

Should the developer choose to have a green building certificate, MODON must be notified and receive a copy of the certificate once the project is completed.

Low-Carbon Renewable Energy Production

MODON recommends the study of solutions and techniques related to production of low-carbon renewable energy within the boundaries of the site, which helps reduce energy consumption and carbon emissions as well as use of fossil fuel rather than traditional fuel.

MODON also recommends studying the possibility of applying the below techniques, developing possible solutions, and applying them on-site:

- Thermal solar energy (for water heating);
- Photo-voltaic cells;
- Geothermal heat pump;
- Wind turbines;
- Bio-fuel;
- Mixed thermal energy.

Selected solutions must be presented to MODON within a study containing the below data at the least:

- Volume of generated energy using the suggested system (percentage of annual consumption);
- Financial recoupment and impact on lifecycle;
- Impact on land use;
- Impact on surrounding environment;
- Maintenance.
Design Phases of the Warehouse and the Related Utility Buildings
Chapter 7: Design Phases of the Warehouse and the Related Utility Buildings

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7.1 First Stage: Soil Studies for the General Location and Adjustments

This stage includes the following:

1. Conduct needed borings to identify soil properties for construction works clearly showing the land’s topography and levels and defining adequate levels for uses on-site;

2. Industrial permit;

3. Land allocation letter;

4. Prepare a sketch showing the warehouse’s general location as well as surrounding streets with their width and services provided from the industrial city or MODON;

5. Prepare a detailed plan of the general location’s needs in term of storage spaces as well as the administrative building, service locations, and functional relationships among all elements;

6. Prepare the preliminary plan of the general location showing doors, entrances, warehouse buildings, electricity rooms, and guard’s room according to functional relationships among the different components as well as the internal road network, waiting areas, loading and storage locations as well as general facilities buildings and any other element needed for the general location along with preparing an information sheet of the warehouse by the consulting company designing the warehouse;

7. Prepare a program for exploitation of areas and setbacks;

8. Warehouse needs in term of electricity, potable and utility water and produced sewage quantities;

7.2 Second Stage: Preliminary Building Design

After the first stage, initial drawings are made for buildings architectural designs (including guard's room, electricity room, wall, and any other buildings within the general location) and include ground and upper floors horizontal projections.

After adoption of initial designs, work starts on final designs for the projects; they include the following:
7.3 Third Stage: Final Design Stage

**Architectural Works Plans**
- The general location’s plan showing the building’s location including storage areas, preparation, loading and unloading spaces, shipping and receiving offices, workers and employees offices, needed services, in addition to loading and unloading bays, marshaling areas, truck parking spaces, internal roads and car parks, entry and exit roads for cars, workers, and truck showing all dimensions and sizes knowing that the scale of the drawing shall be of 1:500 at least according to the warehouse surface in addition to the relation of the warehouse to surrounding roads and uses;
- Plan of the horizontal projection of the warehouse’s main building showing all dimensions and sizes as well as levels of all the different sections from the source in addition to columns and other load-bearing pillars at a scale of 1:50 or 1:100;
- Plan of horizontal projections for all floors of administrative buildings and workers’ services and prayer room or any other building at a scale of 1:100 showing all dimensions and sizes;
- Detailed tables for openings – doors and windows – with a complete description of the quality of these openings;
- Finishing of floors, walls, internal ceilings, and external facades with sectors plan for administrative buildings, workers’ services, prayer room or any other building at a scale of 1:100 showing levels, heights, external finishing for facades, heat insulation, and rain protection;
- Plan for the electricity and guard’s rooms at a scale of 1:50 showing horizontal projections, sectors, and facades with all sizes, levels, and finishing with a plan showing the external form of the fence and gates with all details at a scale of 1:50 at least; noting that reticulated fences may not be used and that the fence should be in accordance with the model used and adopted by the MODON.

**Construction Works Plans**
Construction works requirements include maps showing all construction elements (both concrete and mineral) using the below specification:
- The design shall be in accordance with Saudi codes and standards;
- The file shall include all catalogues and detailed drawings for metallic structures and pre-cast slab and other elements necessary to clarify the warehouse from a construction point of view.

The following plans are presented:
1. Horizontal projection of foundations for all the project’s building showing axes (same as in general location) as well as symbols of bases and columns and full-dimensional details, reinforcing iron, concrete stress, type of cement used in foundations and construction levels for all parts as well as insulation methods for foundations, in addition to soil stress taken into account during design of foundations and all loads taken into account in the design.
2. Plans of above-ground level facilities showing structures, ceilings, and main beams (metal or reinforced concrete facilities. These plans
shall include reinforcing, explanatory sectors, and construction separators, etc.

3. Plan showing distribution of arming iron for vertical projections and sectors of beams and columns for main sections at an adequate scale while also showing distances among stirrups.

4. Construction plans for ground and upper water tanks showing reinforcing iron, dimensions, and levels.

5. Construction plans for analysis tanks, inspection rooms, and septic tanks showing all details after taking into account soil stress in various industrial areas.

6. Construction works for fences, the guard’s room, and the electricity room.

7. Plans showing dimensions and sectors of the metallic structure of main and secondary beams as well as it fixture method and turnbuckles.

8. In addition to the above, construction plans must bear all important remarks by the designing architect such as:
   - Maximum stress allowed for concrete;
   - Maximum stress allowed for reinforcing iron;
   - Specifications of iron used in metallic structures;
   - Specifications of welding used in metallic structures;
   - Specifications of bolts used in metallic structures;
   - Necessary specifications and precautions to cast the concrete in a good way for it to be of the required quality;
   - Necessary and sufficient time for keeping turnbuckles before removing them;
   - Practical ways of installing metallic structures;
   - Necessary requirements for general safety during execution;

- Temperature degrees on which the facility was designed;
- Wind speed and method of calculating resulting pressure that the facility can bear;
- Earthquake magnitude that can be handled;
- The difference of maximum landing below bases.

**Plumbing Works Plans for the Location**

The following plans must be submitted:

1. A topographic plan showing earth level and the levels of surrounding streets with a contouring plan when the land is un-leveled;

2. Plan showing the location of existing services on the surrounding streets such as water and sewage networks as well as inspection rooms, and defining the internal level and stormwater network, noting that it’s preferable to compare current levels with the closest benchmark;

3. Plans showing the final floor slab surface at 30 cm above the final surface of the sidewalk, keeping in mind that the difference in levels between floors surface at the gates and the facing street surface shall not be below 15 cm;

4. Plans containing the below:
   - Horizontals sectors of roads showing locations of services’ installations with floor standard details;
   - Standard details for slopes (if available);
   - Inspection rooms with clarification of their dimensions, internal bottom level and gradient, and distances between rooms;
   - Specifications of inspection room’s cover with its base and resistance of loads, clarifying the size of the opening internally, noting that it should be 60 x 60 cm.

**Water Tank Plans**

Water tank plans must include the below:
- Internal and external capacity of the tank according to warehouse needs;
- Clarification of the ground’s level on nature and the final level of the tank’s bottom;
- The space between the ceiling of the tank and the highest water level in it shall not exceed 50 cm;
- The tank must have an opening with a cover and a base as well as the cover’s resistance to weights clarifying the size of the opening internally knowing that it should be a minimum of 60x60cm;
- The tank must have a ladder made from anti-rust material such as aluminum, stainless steel, and galvanized iron;
- A pipe to aerate the tank with a net to protect it from insects;
- Achieve total insulation of the walls, ceiling, and floor of the tank to avoid water leakages into the tank and out of it.

**Potable/Utility Water Plans**

Plan clarifying potable water installations system for the project at a scale of 1:500 including the below:

- Location, diameter, and path of pipes;
- Water tanks sufficient to meet the needs of the warehouse and it is recommended that the reserve should last for 3 days with a minimum of 1 day;
- Pumps room;
- Capacity and strength of pumps with provision of a spare pump;
- The pump should include a water pressure tank;
- Provision of valves on section’s exits;
- Casting concrete blocks to prevent pipes from moving on bends and branching spot rod;
- Providing necessary extensions with the pump clarifying this with an illustration.

**Sewage Tank Plans**

Sewage tank plans must include the below:

- Internal and external dimensions of the tank according to the required capacity;
- Clarification of the ground’s level on nature and the final level of the tank’s bottom;
- The space between the ceiling of the tank and the highest water level in it shall not exceed 50 cm;
- The tank must have an opening with a cover and a base as well as the cover’s resistance to weights clarifying the size of the opening internally knowing that it should be a minimum of 60x60cm;
- The tank shall have a ladder made from material resistant to rush sewage water;
- A pipe to aerate the tank with a net to protect it from insects;
- A separation wall above water level so that the length of the entering sewage water room is equivalent to two thirds of the total length of the sewage tank.

**Sewage Plan**

The plan must be at a scale of 1:500 and include locations and diameters of pipes and inspection rooms as well as the tank.

**Stormwater Drainage Plan**

- The plan must be at a scale of 1:500 including the below:
  - Levels;
  - Drainage pipe diameters;
  - Inspection room with clarification of its dimensions, internal bottom level and gradient, and distances between rooms;
- A sketch of plumbing works networks including rising pipes;
Third Stage: Final Design Stage
Design Phases of the Warehouse and the Related Utility Buildings

- Plumbing works’ unit data matrixes;
- Various needed details for plumbing works;
- Specifications of plumbing works and quantities table on all calculations, documents, and plans prepared in accordance with requirements of civil defense, Saudi codes, or accredited international standards such as the International Plumbing Code – IPC.

**Plans of electrical works**

**Master plans**
- Various details needed for electrical works;
- Diagram for projections of all floors for electricity supply works;
- Diagram for projections of all floors for fire detection system works;
- Diagram for projections of all floors for satellite television works;
- Diagram for projections of all floors for control camera system works;
- Diagram for electricity installations clarifying all distribution boards, whether main or subsidiary, with details, emergency loads and all main cables for the building mentioning their sizes and linkage to electricity source;
- Lighting units specifications table;
- Tables for electricity supply units;
- Specifications of electrical works and related units.

**Lighting plans**
- Plans showing lighting of building units including lighting of emergency exits and evacuation paths at a scale of 1:100;
- Plans showing external lighting and lighting of the main site as well as external fences at a scale of 1:200.

**Electrical power plans**
- Plans for building units showing electrical powers, sockets, and circuits for building units at a scale of 1:100;
- Plans for building units showing supply to conditioning and aeration units and pumps as well as electricity sockets showing the supply of these units, sockets, control centers, distribution boards and supply lines’ paths as well as these units’ load tables at a scale of 1:100;
- Plans showing the site’s electrical supply showing main and subsidiary distribution boards as well as cable paths between the main board and those in external equipment locations such as the fire pump, potable water pump, etc and their electrical supply, and showing the location of the subsidiary auxiliary energy source at a scale of 1:200;
- Plans for grounding system at a scale of 1:100;
- Plans for lightening-protection system at a scale of 1:100.

**Plans for low-tension current**
- Plans for building units showing distribution of fire detection system at a scale of 1:100;
- Plans for building units showing distribution of satellite television system at a scale of 1:100;
- Plans for building units showing distribution of control cameras system at a scale of 1:100;
- Plans showing distribution of low-tension current works on-site at a scale of 200:1.

**General Remarks for Electrical Works Plans**

Ground floor plans must include all links with the network supplying electrical energy to the site up to 2 meters away from the building, and define size of links.
Annexes
Chapter 8: Annexes

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### 8.1 Annex I: Tables to be filled in the plan matrix to be submitted to MODON

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<tbody>
<tr>
<td>Warehouse name: .................................. Industrial City: ..................................................</td>
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<tr>
<td>Description of stored items</td>
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<tr>
<td>------------------------------</td>
</tr>
<tr>
<td>Stored merchandise</td>
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<table>
<thead>
<tr>
<th>Table 2: Warehouse electrical supply needs</th>
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<td>----</td>
</tr>
<tr>
<td></td>
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<tr>
<td>1</td>
</tr>
<tr>
<td>2</td>
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<table>
<thead>
<tr>
<th>Table 3: Warehouse water needs</th>
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<tbody>
<tr>
<td>Type</td>
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<tr>
<td>Workers’ needs</td>
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<tr>
<td>Irrigation water</td>
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<tr>
<td>Total need</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Table 4: Quantity of sewage water produced by warehouse</th>
</tr>
</thead>
<tbody>
<tr>
<td>Description</td>
</tr>
<tr>
<td>Sewage</td>
</tr>
<tr>
<td>Total need</td>
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</tbody>
</table>
8.2 Annex II: Commitment of the Company Toward Plans and Designs For Warehouses in Industrial Cities

Date: ........H equivalent to ...........AD
We, the company……………………………………………, with permit number…………………………………………
Tasked by the warehouse owner to prepare engineering designs and plans for residential building for the warehouse of ................................................ on land plot number ...................................................., phase ...........................................\n\n\nCommit and pledge that the warehouse designs are in accordance with all conditions and requirements as follows:
▪ Submitted design works are in accordance with Saudi specifications and generally accepted technical standards;
▪ Designs of the warehouse are in accordance with conditions and requirements of warehouses in industrial cities for all submitted designs (architectural, construction, plumbing works, electrical, industrial safety, and mechanical works)
\n▪ In case of any difference between submitted designs and requirements and conditions of warehouses in industrial cities, MODON's written approval shall be sought.
▪ The consultant bears responsibility for any damages due to any errors in the designs of submitted plans and technical requirements, and MODON’s approval of these designs doesn’t not exempt the consultant from full responsibility for design validity and guarantee for 10 years starting from the date of execution completion on site.
\n▪ Upon submission of final plans for factories' residential buildings, the below phrase must be written on plans: “Plans submitted for the residential building are under the full responsibility of the design company without any liability whatsoever on MODON” signed and sealed by the company.

God bless,........,

Seal

Company name:...........................................
License number:...........................................
Name of manager in charge:.............................
8.3 Annex III: Initial warehouse introduction form

1. General data
   Name of warehouse………………………………………… Address:………………………………………………………………………………………………………..
   Name of warehouse owner………………………………………………………………………………………………………………………………………………..
   Address of warehouse owner …………………………………………………………………………………………………………………………………………………
   Phone number…………………………………………………………Fax number……………………………………………………………………
   Mobile number…………………… Email address……………………………………
   Website………………………………………………………………..

2. Storage
   Storage type………………………………………………
   Storage methods……………………………………
   Means of transport of produced materials and means of circulation within the warehouse………………………………………………………………………………
   Packaging method…………………………………………
   Container size………………………………………………
   Storage methods………………………………………………

3. Expected electrical load:

4. Average daily water consumption: ………………………………………… m$^3$

5. Expected daily sewage volume: ………………………………………… m$^3$
   In the case of warehouses of dangerous flammable material, sewage system must include a system for spill containment to avoid leakage of dangerous material to stormwater and sewage network.

6. Expected workforce:………………………………………………
8.4 Annex IV: Construction permit form

**Construction permit form number**

*Permit type:* .................................................. *Permit number:* ............................................. *Contract number:* .............................................

*Date of issue:* .................................................. *Date of expiry:* .............................................

<table>
<thead>
<tr>
<th>Name of facility/warehouse</th>
<th>Date</th>
<th>Civil record number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Permit number</td>
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<td></td>
</tr>
<tr>
<td>Commercial record number</td>
<td></td>
<td></td>
</tr>
<tr>
<td>P.O Box</td>
<td>Phone number</td>
<td>Fax number</td>
</tr>
<tr>
<td>Mobile number</td>
<td>Email</td>
<td>Signature date</td>
</tr>
<tr>
<td>Land plot number</td>
<td>Land size</td>
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</tr>
</tbody>
</table>

**Plans and supervision**

Execution is carried out according to plans accredited by MODON by virtue of letter number…………………. dated……………………… under supervision of consulting company…………………….

**Company address**

P.O box:................... Riyadh:.........................
Phone:................................. Fax:.................................
Mobile: .................................
Mailing address:.................................
E-mail:.................................
Manager in charge:.................................

The license is valid for 6 months from its issuance date and MODON must be referred to for renewal of the license 5 days before expiration.
Authorization and construction conditions

1. The facility owner commits not to discard any waste and not to harm to industrial city facilities. In case of violation, bylaws for fines and penalties for infraction and water and sewage facilities issued by virtue of a decision from MODON's Board of Director numbers 28 and 29/2004 dated 9/7/1425H based on ministerial decision number 225 dates 16/11/1425H.

2. This license is considered annulled should the tenant not start construction works within six months from issuance date.

3. Erecting a temporary wall (to be removed upon works end) around the site and taking all precautions to avoid any potential harm.

4. Complete an accurate commitment to plans for construction pre-approved by MODON.

5. Hang a copy of the permit on-site in a visible location on an ongoing basis.

6. The facility owner commits not to start erecting the wall before starting implementation of production room.

7. Put a sign at a visible location outside the temporary fence stating the project's name, contractor, consultant, and their addresses.

8. Commit to providing containers to transport waste and remove all rubble from the site and neighboring areas in a timely manner and transport them to allowed places outside the industrial city.

9. The facility owner is responsible for presence of the consulting company authorized by MODON to supervise works and for matching accredited plans with works carried out and submit monthly reports to MODON clearly stating commitment to plans, any violation, or any deviations happening during construction.

10. The facility owner is responsible for coordination with civil defense, electricity company, and service providers in the industrial city.

11. Name of permit holder/deputy
   - Title: 
   - Signature: 
   - Date:

---

Land location

<table>
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<tr>
<td>South</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>West</td>
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</table>

---

Permit issuer
Director

Seal

Industrial City
Construction permit/renewal form number……………… Percentage of completion ………..%
Permit type: ........................................ Permit number:................................. Contract
number:.................................
Date of issue:................................. Date of expiry:.................................

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<td>Commercial record number</td>
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<tr>
<td>Mobile number</td>
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<tr>
<td>Land plot number</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Plans and supervision</th>
</tr>
</thead>
</table>
| Execution is carried out according to plans accredited by MODON by virtue of letter number............... dated......................... under supervision of consulting company.........................

<table>
<thead>
<tr>
<th>Company address</th>
</tr>
</thead>
<tbody>
<tr>
<td>P.O box:.................. Riyadh..........................</td>
</tr>
<tr>
<td>Phone:........................ Fax:..........................</td>
</tr>
<tr>
<td>Mobile:........................</td>
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<tr>
<td>Mailing address:...............</td>
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<tr>
<td>E-mail:........................</td>
</tr>
<tr>
<td>Manager in charge:...............</td>
</tr>
</tbody>
</table>

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11. Name of permit holder/deputy
   Title: ______________________ Signature: ______________________ Date: ______________________

Boundaries

<table>
<thead>
<tr>
<th>Direction</th>
<th>Boundaries</th>
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<td>West</td>
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</tbody>
</table>

Permit issuer
Director

Seal

Industrial City
Information Tables
Chapter 9: Information Tables

9.1 List of Information for Forklifts ................................................................. 159
9.2 List of Information of Trucks and Trailers .................................................. 161
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9.1 List of Information for Forklifts
9.2 List of Information of Trucks and Trailers
### 9.3 List of Information of Area Requirements for Support Services

<table>
<thead>
<tr>
<th>Space</th>
<th>Length (m)</th>
<th>Width (m)</th>
<th>Area (m²)</th>
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<tbody>
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<td></td>
<td></td>
</tr>
<tr>
<td>Warehouse manager</td>
<td>6.1</td>
<td>4.9</td>
<td>29.7</td>
</tr>
<tr>
<td>Staff manager</td>
<td>4.3</td>
<td>3.7</td>
<td>15.6</td>
</tr>
<tr>
<td><strong>Open offices</strong></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Manager</td>
<td>3.7</td>
<td>3.7</td>
<td>13.4</td>
</tr>
<tr>
<td>Assistant</td>
<td>3</td>
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<td>7.4</td>
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<td>3.3</td>
</tr>
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<td>Stock Manager</td>
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<td>3.3</td>
</tr>
<tr>
<td>Bids</td>
<td>1.8</td>
<td>2.4</td>
<td>4.5</td>
</tr>
<tr>
<td>Operation</td>
<td>1.8</td>
<td>1.8</td>
<td>3.3</td>
</tr>
<tr>
<td>Meeting room</td>
<td>3</td>
<td>3</td>
<td>9.3</td>
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<tr>
<td>Interview room</td>
<td>2.4</td>
<td>2.4</td>
<td>5.9</td>
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<tr>
<td>Programming</td>
<td>2.4</td>
<td>2.4</td>
<td>5.9</td>
</tr>
<tr>
<td><strong>Open support services</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Files</td>
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<td>1.5</td>
<td>0.5</td>
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<tr>
<td>Entrance/Reception</td>
<td>9.1</td>
<td>6.1</td>
<td>55.7</td>
</tr>
<tr>
<td>Main aisle (1)</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Secondary aisle (2)</td>
<td>-</td>
<td>-</td>
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<tr>
<td>Photocopier (2)</td>
<td>1.8</td>
<td>1.2</td>
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<td><strong>Closed support services</strong></td>
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<tr>
<td>Mail room</td>
<td>7.6</td>
<td>3.7</td>
<td>27.9</td>
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<tr>
<td>Restrooms (1)</td>
<td>7.3</td>
<td>2.4</td>
<td>17.8</td>
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<td>Guard's locker</td>
<td>1.8</td>
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<td>Changing room</td>
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<td>0.6</td>
<td>1.8</td>
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<td>Cafeteria (3)</td>
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<td>First aid</td>
<td>4.9</td>
<td>3.7</td>
<td>17.8</td>
</tr>
</tbody>
</table>

**Notes:**

1. Estimated at 25% of private offices and offices in open-space areas
2. Estimated at 30% of floor surface for offices in open spaces
3. Estimated area for 50 workers and employees
As part of Modon ongoing commitment to environmental stewardship, this page has been left blank to accommodate two-sided printing
References

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أمانة جدة