Safety guide

warehouses

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> 01 Introduction

It is always risky to attempt an in-depth discussion of such a wide-ranging issue as warehouse safety management. This is particularly true when, as is the case with this guide, the aim is to provide a comprehensive study of the general problems found at these facilities.

Among all the risks to which a warehouse is exposed, fire is the one which normally has the gravest consequences, although it is by no means the only one that must be taken into account. It is also important to consider a number of other risks, including merchandise theft, illegal entry with criminal intent, environmental risk caused by poor warehouse management and even damage caused by the forces of nature.

In view of this, the protection and complete safety of warehouses constitutes a growing concern not only for their owners, but also for insurance and reinsurance companies. For the former, both direct and indirect losses may be incurred as a result of an accident. Some of the consequences faced in such cases include the destruction of goods or warehousing facilities, damage to corporate image and loss of customers and earnings.

For insurance and reinsurance companies, in most cases loss events in warehouses constitute evidence of the vulnerability of this type of facilities and, indeed, it has been shown that a warehouse fire generally results in complete destruction of the facilities. The rising trend and increasing importance of warehouse loss events has forced the insurance sector to revise policy conditions traditionally offering excessively favourable terms for warehouses compared to those for production facilities.

The objective of this guide is to provide assistance to the reader in identifying the general risks faced by all parties involved in complete warehouse safety management.

As a result, the guide facilitates decision-making aimed at mitigating or anticipating potential losses by eliminating or controlling risks and by implementing preventative and corrective measures. In short, this guide will provide an effective tool for warehouse risk management.

> 02

Warehouse design

Whenever one intends to start up or expand an industrial or business activity, it is necessary to gather as much information as possible. Buildings, plant, equipment and warehousing facilities will all be required in order to develop the activity.

The ideal company situation would involve being able to produce and distribute goods continuously, thereby eliminating the need for a warehouse altogether and removing the requirement of having goods in storage, where they are effectively "frozen" assets. However, the elimination of warehouses is only feasible in specific types of manufacturing, involving *made-to-order* or *just-in- time* production.

Large amounts of raw materials, semi-finished products, auxiliary material, packaging and finished products must be made available to the various users, whether intermediate or final, internal or external. Consequently, the creation of storage areas is necessary in order to enable distribution upon demand at a later date.

Warehouses must be designed and built according to a previous analysis of the movement and relationship between materials and products anticipated in the production process.

Appropriate warehouse design can prevent many future problems and, therefore, the initial design stage should involve consideration of a number of factors, such as:

- The shape and size of the storage areas in relation to the characteristics of the items to be stored.
- The loading and handling methods and the transit areas.
- National, regional and local regulations concer-

Storage in aisles and transit areas

ning stored goods, such as those applicable to chemical goods storage.

- The warehouse location in relation to the production areas and transportation facilities.
- Accessibility, visibility and easy identification of the Goods.
- Admissible loads on floors and storage structures.
- Free space between the stored goods and the ceiling.

Although it is tempting to classify warehouses, this is a complex task that is beyond the scope of this guide. If necessary, warehouses can be classified according to the type of goods stored and such a method would involve classification as follows: dry, refrigerated or frozen foods; clothes and textiles in general; construction equipment and materials; machinery and spares; and so on. Classification can also be made according to the end customer involved, for example, external or internal customers; retailers or wholesalers; and so on. Finally, classification can even be based on the mechanical loading methods employed, for example, forklifts trucks; transpallets; automated storage and transportation systems; and so on.

Although we do not intend to provide a thorough classification of warehouses, it is convenient to note that in general they can be grouped into four types according to their **"function"** (see Table 1). In this classification, each warehouse **"type"** shares common basic characteristics regardless of the type of goods stored or the size of the warehouse.

In many cases, planned or existing warehouses do not fall clearly into one of these types, but instead share characteristics of several types. Thus, warehouses for refrigerated or frozen products can be included in both the "Services" and "Distribution" warehouse categories, depending on their main function.

Table 1. Classification of warehouses

Type	Functions	Goods stored[1]	Examples of goods	Warehouse characteristics	Warehouse design	Machinery	Examples
Service warehouses	Forms part of and supports a production process.	Raw materials to be processed or mounted.	Wood, plastic, meat, fish etc.	Extremely varied, depending on the production process. For flammable products, hazardous materials, and so on, storage must comply with certain safety requirements (temperature, humidity, insulation, etc.) For products used in the food industry, refrigerated chambers are usually employed.	Depending on the production process, palletised systems, boxes or containers may be used with goods placed on shelving or racking of differing designs according to the product stored.	Diesel or electric forklifts and electric or hand-operated pallet trucks.	Any of those found in factories with production processes of any type.
		Finished products for distribution to customers.	Doors, finished PVC pipes, etc.				
		Materials processed outside established specifications, requiring reworking or withdrawal.	Production remnants.				
		Waste requiring special management.	Used machinery oil, cardboard, etc.				
		Auxiliary material, tools, and so on, used for production and maintenance or in offices.	Soldering equipment, circular saws, hammers, paper, etc.				
Deposit warehouses	Receipt and holding of merchandise owned by a third party.	Finished product in temporary storage. Many items in small amounts with frequent dispatching.	Books, cosmetics, pharmaceutical products, etc.	Maximum storage capacity compatible with the required availability of goods in storage. Computerised control of loads and spaces. Located near large urban centres.	Tends to involve storage at great heights with narrow aisles. Saw-tooth (zigzag) loading bays for use by a fleet of lorries.	Automatic shuttle carriage for internal pallet movement. Automatic retrieval equipment and conveyor belts. Own lorry fleet providing a service for the clients.	Companies providing storage, transport and distribution of merchandise, such as couriers or carriers.
Logistics warehouses	Grouping and distributing goods at strategic geographical locations to enable improvements in the operation of the company's activities.	Goods owned by the company.	Drinks, clothes, etc.	Requiring rapid docking, unloading and loading. Warehouse capacity must remain uniform. Located near large urban centres or strategic transportation points.	Pallets stored at a height of 2 to 4, wide aisles allowing forklifts to pass one another. Saw-tooth (zigzag) loading bays for simultaneous use by several lorries.	Forklift trucks able to move large pallets and the use of automated systems. Lorry fleet providing a service for the company.	Large companies requiring warehouses located between the factories, distribution centres and final retail outlets. Obvious examples are large clothing companies with their own city-centre shops.

Type	Funtions	Goods stored[1]	Examples of goods	Warehouse characteristics	Warehouse design	Machinery	Examples
Distribution warehouses	Used as "reservoirs" of large amounts of goods which are transferred to consumers without subsequent transformation. They constitute provisioning points for food and drink outlets.	Goods belonging to other companies, which are stored temporarily prior to distribution to food and drink outlets.	Food products in general (drinks, canned goods, etc.), agricultural products (fruit, vegetables), products from livestock (meat) or from the sea (fish, seafood), etc.	Compact storage on pallets, with loading taking place at one end and unloading at the other. Refrigerated chambers and/or freezing tunnels may be present, depending on the product stored.	Large shelves with palletised storage and generally wide aisles.	Manually operated forklifts and pallet trucks.	Central warehouses of a large retail network selling directly to the public and distributing products to smaller retail outlets. Common in the food sector.

[1] For all warehouses, there is usually storage for the back-up materials on which the goods are placed, such as wood or plastic pallets, containers, boxes, bins, and so on. These materials also require their own storage area.

> 03

Warehouse risks and preventative measures

In general, the risks to which warehouses are exposed relate to a number of factors. Past experience and statistics concerning warehouse loss events both demonstrate that they form a significant part of the total losses in industrial environments as a whole.

Adequate business risk management practice requires an initial identification of the hazards to which the company is exposed, followed by appropriate risk assessment, and subsequent implementation of plans for risk prevention and control. The risks concerned do not only include the most typical ones such as fire, but also explosions, illegal entry into the workplace involving the possibility of theft or vandalism, environmental damage which may occur due to accidental spillage of toxic products, falling shelves, knocks and damage to shelf and rack structures or merchandise, and even risks generally classified as natural catastrophes, such as floods or storms.

All measures implemented to minimise these risks must be closely interrelated and must be carried out in addition to suitable warehouse maintenance and frequent safety condition checks. Only then will the effectiveness of the safety system chosen by the company be ensured.

3.1. Fire risk

In general, storage of goods does not entail a high likelihood of fire unless the materials themselves represent a special risk, as would be the case when storing explosives, fuels, solvents, and so on.

Fire extinguishing work at a warehouse

However, when fires in warehouses do occur, they almost always have devastating consequences. This is because difficulties often arise when trying to control and extinguish fires at the initial stage, even when automatic fire-extinguishing systems are installed throughout the warehouse.

Results of a fire in a perfume warehouse (Source: Munich Re)

The variables that have a significant effect in causing a fire and resulting in spreading it are numerous and can be interrelated. As a consequence, it is often difficult to establish the exact origin of fires and to reduce their occurrence in warehouses by acting on only one of these factors. Experience of warehouse fires shows that extensive damage occurs as a result of factors such as the following:

- Late discovery of the fire.
- Rapid fire spread.
- Inadequacies in storage space layout and design.
- Lack of compartmentalisation.
- Bad housekeeping.
- A disproportionate amount of stored goods.
- Generation of a high level of toxic fumes and gases.
- Absence of automatic sprinklers.
- Absence of a damage reduction and action plan in the event of emergency.

The main factors or circumstances that influence the increasing incidence of warehouse fires are discussed below.

3.1.1. Ignition sources

Fire occurs due to the rapid and continuous combustion of a material. This requires three basic elements:

- **Fuel**, which is the element that burns. Examples include paper, cardboard or petrol.
- **Oxygen**, found in the air and present when certain substances decompose.
- **Energy**, to raise the temperature of the fuel to its ignition point, for example, a flame, sparks or lightning.

The **energy** needed to start the combustion is one of the elements which must be present in order for a fire to start. This energy comes from an **ignition source**, which is defined as something with sufficient energy to raise the temperature of the stored goods and produce a fire.

Common ignition sources in warehouses include:

a. **Power installations**, such as electricity, gas or heating installations. The risk is greater when these are poorly maintained or located near the stored goods.

   Electrical installations are the origin of many fires and there are several factors which can increase this risk. These include:

   - Damaged or poorly insulated electrical wires, leaving conductors exposed, and so on.

   - Failure to use the correct size of electrical conductor protection, leading to overheating.

   - Multiple use of the same electrical socket, causing overloading at a particular point in the electrical network.

   A suitable way to prevent fires due to the existence of electrical installations in poor condition is to introduce predictive maintenance. This includes carrying out thermal imaging (thermography) at least once a year.

   Thermal imaging is a technique which uses an infrared camera to measure the surface temperature of different components. In most cases, electrical faults are preceded by increased temperatures at the weakest point of the installation. This technique is extremely useful since it facilitates detection up to months in advance of defects which could cause a breakdown leading to process stoppage or, in the worst case scenario, a fire.

Thermal imaging analysis of a main switchboard. Real image on the left, thermal image on the right.

   In addition, goods can become hot and catch fire if they are stored near energy sources such as heaters or lighting which is heat-producing.

   Goods must be stored at least 1 metre from any lighting or heat-producing source (an air heater, a ventilation fan, a blow torch etc.) which could cause a fire.

   Lightning should also be protected against possible impact from goods so that their breakage and the resulting hazardous situations are prevented.

Plastic material stored near lighting

b. **Ignition sources characteristic of the manufacturing process**. These can be found in storage areas inside industrial processes which use heat or open flames, such as industrial furnaces.

c. **Ignition sources associated with storage processes**. Warehouses often use machinery to handle goods. This machinery may be electrical or powered by thermal engines using diesel oil, petrol or gas. Machinery can include forklift trucks, pallet trucks or lifting equipment. In general, indoor warehousing uses electrical equipment requiring a battery power supply which must be recharged periodically using **battery chargers**.

   Battery chargers present a particular risk because during the recharging process, they release **hydrogen gas**. This is explosive even though it may only be present in the air in very low concentrations and, as a consequence, the presence of combustible or flammable material around the battery-charging area increases the fire and explosion risk in the warehouse.

   The following recommendations should be followed in relation to **battery-charging areas**:

   - Anti-explosion trucks must be used in areas where there may be explosive or flammable gases, vapours or dust, in accordance with the current regulations.

   - The battery-charging area must be free of ignition sources and well ventilated.

   - Electrical installations must comply with the provisions of the Electrical/Technical Regulations.

- Necklaces, bracelets, watches or any other metallic objects which could lead to short-circuits or sparks must not be worn during battery handling and charging operations.

- Lighters or live flames must not be used to check charging levels.

- In automatic battery-charging operations, only the number of batteries specified by the equipment manufacturer must be recharged simultaneously.

Material stored next to a battery charger (up) and obstacle-free battery - charging area (down)

- Daily and period checks of circuits, tanks, couplings and battery elements and circuits.

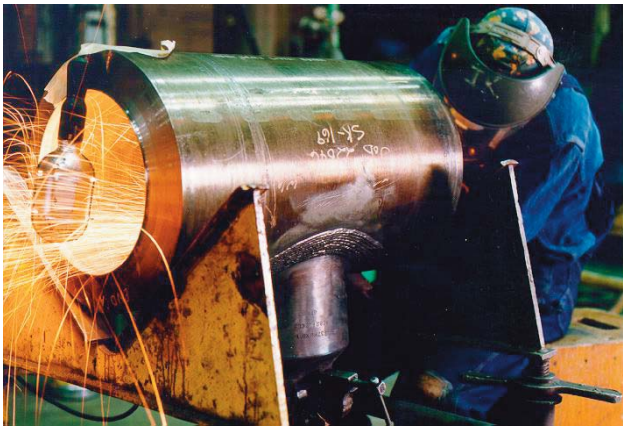
- Daily and periodic checks of combustion systems and/or electric batteries.

In the case of equipment powered by **thermal engines**, sparks can occur in the exhaust pipe, potentially leading to a warehouse fire. This is particularly true if there are explosive atmospheres involving explosive or flammable gases, vapours or dust. In such cases, it is advisable to provide flame-extinguishing or spark containment devices around the exhaust pipe outlet.

d. **Other possible ignition sources**, albeit not common in warehouses, are those related to hot work. This type of work includes all operations which generate heat, sparks, flames or high temperatures and which, in the presence of flammable or combustible materials can cause a fire. This is the case with certain tasks performed in general warehouse maintenance, such as soldering, circular sawing, drilling, and so on.

   Execution of these tasks in a safe manner requires certain basic safety measures to be followed. APPENDIX 1: HOT WORK PERMIT includes a safe working procedure for this type of tasks.

e. **Another potential ignition source** of no less importance is that related to poor practices by smokers. Controlling this risk involves creating specific smoking areas and forbidding smoking elsewhere. No-smoking signs must be displayed and staff must be appropriately informed of their obligations. These prohibitions must be strictly observed and periodic checks should take place at least once a month.



Sparks from filing processes can be propelled a considerable distance

f. **Ignition sources** associated with the **process of using heat to shrink wrap** products, which involves wrapping the goods in a thin plastic film. Some warehouses use this technique to protect the goods against breakage or becoming worn in appearance.

   Shrinking-wrapping processes may require the use of heat to seal the plastic film. The heat is generally supplied by a soldering electrode or electrical resistor incorporated in the shrink-wrapping device. The plastic material used is often highly combustible (for example, polypropylene or polyethylene.) and therefore the risk of fire is considerably increased.

3.1.2. Fire load

Fuel is the second factor involved in the origin of a fire and to understand its role, it is necessary to discuss what is known as the **fire load**.

In general, the fire load of a warehouse is calculated by considering, among other factors, the quantity and the **heating value** of each combustible material present, including construction materials.

What is of most importance here is the **nature** of the materials or goods stored. Depending on their characteristics, the rate of **fire spread** will be higher or lower. The severity of a fire will obviously depend on the **combustibility of the material**. On the whole, plastic and synthetic materials tend to burn faster than ordinary or natural materials such as cardboard. In this respect, we need to differentiate between:

a. **Stored goods**, including their packaging (paper, plastic, etc.). Consideration needs to be given to whether the warehouse is located in high-risk premises, as would be the case where activities such as painting and varnishing take place. This represents a considerably higher risk of fire and/or explosion.

   If the warehouse contains a high-risk product (for example, paint, oils or aerosols) in a small quantity in relation to the overall products stored, it is recommended that this product is isolated and given specific protection. External storage or confinement by the use of segregation devices or partitions providing at least one hour's resistance to fire is advisable.

b. **Construction materials**, including those used to build the warehouse structure, (concrete, wood, metallic structures, and so on), those used to cover the structure, (fibre cement, sheet metal, fibreglass, and so on) and those used to insulate or finish off the roof and walls (plaster, polyurethane, and so on). The use of insulation materials such as polyurethane or polystyrene increases the fire load due to their high degree of combustibility.

To prevent fires related to the fire load occurring, we recommend the following measures, many of which are related to **good housekeeping and practices** at the warehousing facilities:

- Products that represent risks which may cause exceptional damage (such as dense smoke) or corrosive atmospheres should be stored separately from products which are especially vulnerable to such risk.
- The aisles and corridors separating goods can provide considerable advantages when faced with a fire fighting and rescue operation. The most appropriate aisle width depends on the foreseeable seriousness of possible fires, but in general terms, aisles of 2.4 metres will suffice. If possible, aisles should lead to the doors or windows in order to facilitate access.
- A separation distance of at least 60 cm should exist between the stored goods and the walls of the building. This is particularly important if the product expands when wet.
- Goods should not be stored so that they are higher than the lower part of roof beams or too close to roof trusses. If there are automatic sprinklers, it is advisable to ensure that a 1 metre separation distance exists between the highest storage point and the sprinkler heads. The minimum separation distance required is 60 cm. In the case of fire detectors, the recommended distance from stored goods is also at least 1 metre.

Storage reaching the ceiling

- Empty pallets must be stored outside production and warehouse buildings and be placed so that an adequate distance separates them from external walls of the building.
- The correct location of highly hazardous products, such as toxic, corrosive or flammable materials, is also important to reducing fire load. Such products must always be placed in specifically designated areas and sectioned off from other areas.
- In external storage areas, it is necessary to ensure that no additional risk arises due to the proximity of the stored goods to external equipment (transformers, refrigeration towers, fuel tanks, etc.), buildings or power lines.

3.1.3. Oxygen

The most influential factors which can cause a fire to start and then spread are:

a. **Type of storage**. Generally, **indoor warehouses** are designed with a specific storage capacity. However, financial reasons mean that the storage space is used to a maximum, leading to high stacks with minimum separation distances between them and, sometimes, the accumulation of large quantities of material in one area.

   In the case of **"block stack" storage**[2], the more free space there is inside the stacks, the more serious the fire becomes because the air can circulate more freely, favouring combustion. Conversely, the denser the stacks are packed, the less serious the fire. Fire intensity will also increase in line with the height and the stability of the stacks. Stable stacks are unlikely to collapse and therefore present fixed surface areas, which favour fire spread. On the contrary, stacks which fall or collapse will generally help to control the fire.

Paper rolls stacked vertically

   Waste must be classified and deposited in suitable containers. If possible, these should be located outside the production and warehouse buildings and separated from the external walls of the building. In all cases, waste must be appropriately dealt with or removed periodically.

   Concentration of combustible materials must be avoided in areas used for packing, unpacking, classification, and so on.

   The seriousness of a fire is also affected by the amount of free space, such as that found between the different layers of **storage on pallets**[3]. Such spaces allow the fire to spread, but unfortunately are not normally reached by the water used in fire fighting.

Stacks stored on pallets

Both **shelf and rack storage**[4] is common in warehouses. An explanation of both types is provided below:

1. **Shelving**, in which the stored loads are generally packaged goods placed on solid metal shelves or boards.

Shelving

2. **Pallet racking**, in which the palletised loads are placed on supporting beams using mechanical lifting equipment (such as forklifts) or hand-operated equipment (such as pallet trucks)

Pallet racking

[2] "Block stack" storage refers to storage without free horizontal spaces and/or with spaces located at heights above 2m
[3] Palletised storage is that in which the use of pallets creates free spaces at intervals of less than 2m in height.
[4] Shelf and rack storage refers to the use of fixed shelving or racking where the goods are placed on pallets, solid shelves or in boxes

As outlined below, **shelf and rack storage** can also be classified according to the **quantity of goods handled and the degree of warehouse automation**:

- **Automated warehouses** are suitable for both boxed and palletised goods stored on shelves or racks. Loads are handled automatically by retrieval equipment which brings them to the operator station. The warehouse consists of a central aisle in which the retrieval robot moves. The load handling area is situated at one end of the shelves or racks. The entire system is controlled by management software, which records the location of all the goods in the warehouse. The advantages of this type of warehouse are:

  * Automation of the product entry and exit operations.

  * Savings in space and time devoted to storage tasks.

  * Elimination of manual handling errors.

  * Easy inventory management, updating and control.

  * Retrieval equipment guided by management software which coordinates all warehouse movement operations.

- **Self-supporting warehouses**, which are designed so that the shelves and racks form part of the structure of the building itself, along with the roof and warehouse walls. They facilitate varying degrees of automation in storage processes and they tend to be very high warehouses.

Metal shelves for light loads

- **Gravity flow racks**, consisting of racks with slightly inclined roller-form pallet supporting beams. Pallets are loaded in one side and then flow under their own weight to the opposite side for picking. They work well for products where FIFO (first-in-first-out) rotation is necessary.

- **Shelves for light loads**, designed for use in manual goods handling. This wide-ranging and varied system is applied in many different sectors, ranging from the storage in small scale operations to storage in complex industrial sites.

  Storage on shelves presents considerable complications from the point of view of fire protection. Normally, this arrangement increases the number of surfaces that can burn and allows a greater inlet of air, causing greater combustion. The stored goods are also maintained in a stable position, which is an "ideal" burning arrangement. Additionally, this storage configuration, particularly at great heights, means that water from sprinkler systems fails to enter the free spaces or gaps, which are often narrow. The narrower and higher the spaces are, the more difficult it is for the water to enter. The final result is a more long-lasting fire.

  A further aggravating factor in these cases is the lack of anchoring or tethering of shelves to a solid and stable point of the building. In the event of a fire breaking out on one of the shelves, it will deform and may collapse, leading to a domino effect which causes the other shelves to fall.

b. The design and layout of **vertical and horizontal hollow spaces and openings** in the building. Vertical spaces include stairwells, lift shafts, interior courtyards, and so on and horizontal ones include openings such as doors, forklift truck access and windows. The existence and layout of these spaces can favour fire spread once a fire is started. Fire spread will also be favoured by a lack of appropriate **compartmentalisation** or sectorisation[5] between the storage and production areas, or even between different storage areas in the case of large warehouses.

3.1.4. Risk vulnerability

In addition to the factors outlined above, other factors which lead to increased vulnerability to risk include the fragile nature of certain valuable merchandise and the severity of the damage that may be caused to the warehouse or merchandise by certain building materials. The following are included among these factors:

[5] Compartmentalisation or sectorisation: the space enclosure system designed to eliminate or prevent the possibility of fire, smoke, fumes and gases spreading to other fire area.

a. The existence of electronic or precision equipment of great importance to the company.

b. The existence of documents or files of high strategic value to the company.

c. Products liable to suffer damage due to combustion gases or as a result of environmental conditions producing rust.

d. Luxury or valuable goods.

e. Food products, such as fruit, vegetables and meat which can suffer irreparable damage due to combustion fumes. Further complications exist with these products due to the use of **refrigerated chambers to** store such goods prior to shipment to the final user. The **sandwich panels**[6] used to construct these chambers present an added risk factor.

   Highly-combustible organic material, such as polyurethane or polystyrene, is normally found inside the panels and if a fire starts in their interior, it generally spreads quickly.

   In addition, a large amount of toxic fumes is also produced. Controlling and extinguishing this type of fire is a complex matter because the organic material is confined between sheet metal. Even if water is constantly sprayed on the panels, the cooling effect is not sufficient to put the fire out and it continues to burn on inside.

   There are other factors which can increase risk, such as those arising from the use of flammable and/or explosive refrigerating gases, such as ethane or propane. A leak in the refrigeration circuit can produce a flammable atmosphere which results in an explosion.

   These types of refrigerants are not normally used in the food industry. Instead, refrigerants of high and medium safety are generally used. A typical example of this is ammonia. While its intrinsic risk of ignition is low, its toxicity is high. It has a suffocating effect and it is estimated that the maximum risk-free exposure level for humans is 25 ppm. It represents an increased risk not only for people in the surroundings of the refrigerated chamber, but also for the stored goods, which can be contaminated.

   In these cases, if staff members are constantly present, current regulations require either the installation of one or more ammonia detectors with a 2% detection sensibility, or the installation of emergency stop buttons, which should be located outside.

3.1.5. Added risks due to external factors

External factors are those that can increase risk levels due to situations which are foreign to the warehouse itself. They are usually found in the warehouse surroundings. Significant examples of these external factors are the following:

a. Adjacent buildings. Sometimes, the origin of a fire is not in the warehouse itself but in an adjacent building.

Adjacent buildings, which may or may not be communicating

A dividing wall separating two buildings

   The presence of a firewall between buildings or different zones can prevent a fire from spreading from the roof of one building to the adjacent building.

b. Roofs of different heights on adjacent buildings.

c. The presence of trees or undergrowth around the warehouse can cause a fire to spread to the inside of the warehouse. Ideally, the warehouse surroundings should be kept free of undergrowth.

[6] Sandwich panel: a structure containing insulating material enclosed between two outer panels which are generally made of metal.

Undergrowth outside the warehouse increases risk of fire

d. Fires caused by third parties foreign to the warehouse, which is called arson. This may occur due to the burning of pallets placed outside the warehouse, crates, and so on in agricultural cooperatives.

e. **Outdoor storage in warehousing facilities**. Generally, the use of such facilities is not advisable due to their exposure to a large number of possible ignition sources of external origin, such as direct impact by lightning, fires caused by persons foreign to the warehousing facilities, the presence of undergrowth which may cause a fire to spread, and so on. The installation of automatic protection measures is not feasible in such circumstances. Despite this, the use of exterior warehousing or storage facilities is justified in certain cases:

   * Products with low fire-risk levels (such as empty metallic drums) which do not require fire protection, even when inside buildings.

   * Products of low value that do not justify the use of indoor storage areas.

   * Products of low value with high fire-risk levels (such as empty pallets).

   * Bulky products stored in amounts that make covered storage impractical (such as paper, wood, etc.).

   However, even in these cases of apparently little importance, it is necessary to evaluate and consider certain conditions to ensure proper protection.

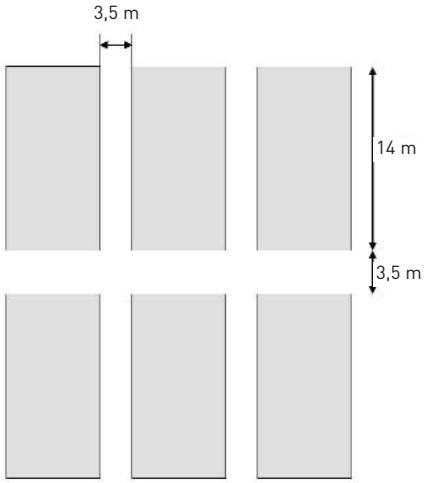
   The first assessment necessary is to ensure that goods stored outdoors do not represent a hazard which could cause an interruption in normal business activity, production stoppage, or any damage to third parties such as adjacent companies.

   The second consideration refers to the location of the stored goods. You must ensure that this does not create the possibility of exposure to fire risk to external equipment (transformers, refrigeration towers, etc.), buildings, power lines, pipes, channelling ducts, and so on.

The area must be well lit and, if possible, provided with a protective fence to prevent intrusion.

You must also consider the characteristics of the stored goods. Stacks of materials must have a specific volume and height. It is not advisable to have volumes greater than 700 m^3 or heights of more than 6 metres.

Empty pallets should be arranged in rectangular areas, in an orderly fashion and observing the following parameters for each rectangle:



Outdoor pallet arrangement

- Maximum storage height: **h = 7 m**
- Maximum length of the longest side of the rectangle: **L max. = 2h = 14 m**
- Maximum surface area of the rectangle: **S max. = 100 m^2**
- Minimum separation distance between storage areas (aisle width): **h/2= 3.5 m**
- Minimum separation from walls of the building: the same as the storage stack height, or if this is not possible, at least 3m.

It is also necessary to ensure that adequate aisle width exists between the stacks to allow manual fire fighting with hoses.

In respect of manual fire fighting, it is advisable to have portable fire extinguishers strategically distri-

buted and to have hydrants with a separation distance of no more than 80 m between each one.

Good housekeeping and periodic inspections of the area are essential to ensure minimum safety conditions are met. Site security patrols should include these outdoor storage areas to detect any anomalies as soon as they appear.

3.1.6. Fire protection measures

The fire protection measures installed at the premises influence the ability to control fires and to extinguish them with the minimum possible consequences.

The first measure to consider in this respect concerns warehouse **construction characteristics**.

Given their high heat-resistance levels, the most advisable construction materials are concrete and steel coated with plaster or fibrous silicate panels, or even sprayed with a layer of perlite or vermiculite mortar.

When steel is protected with intumescent paint, firstly it is important to ensure that its application covers the entire structure. No less important is maintenance, particularly in areas which could be affected by knocks. In any event, such coatings for metallic structures are not effective against lasting or intense fire, as is foreseeable in the case of warehouse fires.

The next preferred choice in terms of construction materials involves the use of large, heavy wooden beams because of their slow combustion and structural stability compared to an uncoated metallic structure.

Metallic structures without additional protection against fire are not advisable. Steel begins to become unstable when subjected to temperatures above 538 ºC, even if only for a few minutes. Heat deformation of the structure can lead, among other problems, to the roof collapsing or falling in and to the pipes of the fire protection installations breaking. The resulting water loss will lead to the fire protection installations malfunctioning, leaving any fire completely beyond control.

Constructions with combustible materials, including light wood, are not advisable in view of their rapid combustion.

Another important factor is warehouse **ventilation**. Under "normal conditions", a fire spreads in two directions: horizontally (following the distribution of the combustible material) and vertically. As the fire advances, the heat rising vertically steadily increases and hot combustion gases accumulate under the ceiling. When the heat spreading from these gases to the roof and the structural elements of the building becomes intense enough, the building may collapse.

Experience gained of fires inside buildings shows that this problem can be overcome if the windows of the building are located near the roof. This means that when their glass breaks due to the temperature change, the combustion gases and generated heat dissipate through the openings. As a consequence, the heat exchange with both structural elements and the roof is minimal and, therefore, the damage caused by the fire is also minimal. This effect is more pronounced in buildings with metal structures than in those with concrete structures, given the higher heat conductivity of the former.

In general, the ventilation provided by windows or openings located in the higher sections of the façade or roof is enough to dissipate hot gases generated by fire. Nevertheless, national, regional or local regulations may require the installation of **smoke and heat vents**.

Lastly, another factor affecting the capacity to control and extinguish fires is the presence of **active protection measures**. Among the most important measures are:

- **Automatic detection systems** installed to allow fire fighting to begin as soon as a fire starts. These systems must be connected to a 24-hour alarm reception system.

Obstructed automatic detectors

Another point to consider when installing detectors is that an obstacle-free radius of at least 1 metre must be left between the detector and the stored goods.

- **Automatic extinguishing systems**. The best way to prevent a warehouse fire from spreading is by installing **sprinklers**.

When a decision is made to use sprinklers to protect a building used for warehousing or storage purposes, it is important to ensure that the entire building and any communicating buildings are also protected. Buildings are not considered to be communicating when the division between the buildings consists of a wall with a fire resistance level of at least 60 minutes. Doors or openings must be designed to close by themselves, or automatically, in the event of fire. Their fire resistance must be at least half that of the dividing wall.

To guarantee the effectiveness of a sprinkler system, the recommended distance between any combustible materials stored outdoors and the building(s) protected by the automatic sprinklers must be at least 10 m or 1.5 times the height of the stored goods. This recommendation can be ignored if the materials are segregated from the building by an exterior wall with a fire resistance level of at least 60 minutes and there are no openings which could allow the fire to penetrate.

Pallet storage segregated by an exterior wall

Automatic sprinkler installations normally provide adequate protection for metallic structures. However, for certain high-intensity or severe fires, such as those occurring with plastics or flammable liquids, additional protection for the structure may be required (paint, coating, and so on).

The calculation and design of a sprinkler system must comply with the current Standards. For the design to be considered adequate, the system only needs to provide protection for the shelf and rack structures and, therefore, it will not provide protection for the materials stored in the spaces or gaps inside them. Obviously, this represents a fire risk.

In general, it should be noted that the water from the sprinklers provides fire control for a specified area and additional measures in the form of hoses will always be required to extinguish the fire. Only ESFR (Early Suppression Fast-Response) sprinklers are designed and approved to extinguish fires, but always within specific design limits according to the height of the storage space and the slope of the roof, among other factors.

- **Manual extinguishing equipment**. This includes fire extinguishers, fire hose cabinets equipped with 45 mm hoses, and fire hydrants. Although the use of 45 mm hoses involves greater difficulty, this does not justify the use of 25 mm hoses, which have a much smaller capacity. This drawback can be overcome by appropriate staff training in emergency procedures.

  Layout of the storage space and goods must not involve an increase in the safe distances specified for manual fire protection systems, which are as follows for any occupied area:

  - 25 m to the nearest fire hose cabinet.

  - 25 m to the nearest alarm button.

  - 15 m to the nearest extinguisher containing suitable extinguishing agents.

On one hand, the effectiveness of fire protection systems depends on adequate equipment and installation **maintenance** and, on the other hand, on theoretical and practical **training** of warehouse staff in the use of the equipment.

Proper maintenance requires keeping access to fire protection equipment **visible and obstacle-free. Stored products must never obstruct the fire protection measures**.

Extinguishers obstructed by loading equipment

Maintenance of fire protection equipment and installations must be carried out in accordance with the Regulations on Fire Protection Installations. Investment in safety measures is sometimes rendered useless by improper maintenance. The best way to avoid this is by providing adequate training and by involving plant maintenance staff in the maintenance of fire protection devices. Although certain maintenance operations must be performed by an authorised company, other less complex but equally important operations can be carried out by warehouse staff.

As regards **training**, one must consider that in general the most important factor for detecting and controlling fire is the human factor. It is therefore essential to train staff to enable them to fight a fire at its initial stages. In addition, it is equally important to develop an updated and correctly implemented emergency plan which incorporates training activities involving real fires and annual fire drills.

3.2. Environmental risk

For the most part, environmental risk associated with warehouses is limited to the presence of materials which are potentially toxic for the general environment or the workplace environment.

In this respect, the following hazards can be identified:

a. Hazards related to the stored materials. If they consist of **chemicals or toxic, corrosive or flammable materials**, the main risk concerns emergency situations resulting from accidental spillage. In addition, there is increased environmental risk of **toxic fume emissions** being released into the atmosphere due to a fire in a warehouse containing such products. Some examples of the products involved include household cleaning products, home improvement products, cosmetics and personal hygiene products.

b. Hazards related to equipment used for loading and transportation activities. The main environmental risks are those arising from the **noise** and **exhaust fumes** from lifting equipment or vehicles with diesel or petrol engines. The vehicles may be for indoor use, such as forklift trucks, or outdoor use, such as lorries in loading bays.

   One must also consider the possibility of accidental acid spillage from batteries during recharging operations.

Basic environmental risk safety measures initially involve the suitable classification of the stored goods.

Potentially toxic chemical substances, such as petroleum products, solvents and dyes must be adequately labelled and safety data sheets must be provided for each product in order to enable their use in the event of an emergency. The provision of information and training for workers handling the products is an effective way to reduce risk. This is particularly true since in the event of spillage and subsequent cleaning, it is essential that staff are aware of the risks to which they are exposed and the possible consequences for their own health and the environment.

In certain circumstances, it may be appropriate to install safety guards or rails on shelving and racking to protect them against being knocked or struck by forklift trucks.

Adequate planning and maintenance of the areas where materials are stored is necessary to prevent their loss and/or accidents. The location of different chemical products must be shown on a warehouse map and a record of product entries and exits must be kept. Special attention should be given to the location of mutually incompatible substances which could provoke dangerous chemical reactions.

In general, warehouses in this category must be compartmentalised or adequately sectioned off from other buildings occupied by persons, from other warehousing facilities, and from manufacturing areas. In addition, it is advisable to install collection systems and/or systems for limiting potential damage caused by accidental spillage. Basic examples include containment vats and floors which have been treated to improve resistance to products that may be spilled in the protected area in question.

With respect to the **battery-charging areas or premises** found in many warehouses, the main environmental risks arise from acid splashes or spillage. These can be reduced by installing a waterproof, acid-resistant floor with a slope which allows easier removal of cleaning water and acid spills. Recommendable maintenance tasks include frequent cleaning of the premises and the use of suction to eliminate dust from battery chambers, while taking care not to suction the electrolyte.

Environmental pollution must also be considered. Adequate safety conditions should be maintained with regard to noise and exhaust fumes produced by forklift trucks with diesel engines. Whenever possible, it is advisable to use electric forklift trucks for indoor warehousing activities, not only for the environmental advantages this offers but also because it reduces fire risk. Forklift trucks with thermal engines (whether diesel, petrol or liquefied gas) should only be used in outdoor, well-ventilated areas.

3.3. Natural risks

Natural risks are those caused by natural forces. The magnitude of the losses caused by these forces depends on:

- The intensity of the natural phenomenon.
- Construction methods.
- Protection mechanisms against catastrophes of this type.

Although these type of loss events occur less frequently than fire, their damage potential is usually greater.

3.3.1. Wind

Modern lightweight roofs can have entire roof panels torn off by wind. Walls and wall enclosures can also be affected, leading to the collapse of the building if these are designed only to enclose the structure without providing resistance to excess pressure or excess loads.

Design regulations exist to enable calculation of the wind loads exerted on a building and its roof. Factors influencing design choices include the wind regime and the topographical location of the building.

To prevent wind suction from tearing the roof off, sufficient anchoring provision must be incorporated at the design stage. In addition, the building design must consider possible vibrations caused the dynamic forces produced by the effect of changes between wind pressure and wind suction on the roof.

As a general construction rule, it is advisable to employ systems which distribute wind loads down to the foundations. Such systems include, for example, the use of supporting or load-bearing walls.

To obtain a stronger enclosing structure without introducing excessive weight, steel bar reinforcements can be used.

3.3.2. Flooding, rain, hail and snow

Flooding due to torrential rain

Flooding can be caused by the following:

- As a direct result of water from excessive rainfall.
- Water from the melting of ice and snow.
- Water overflowing from lakes with natural outlets, rivers or estuaries, and other natural surface waterways.
- Water from rough seas along coastlines.
- Water from burst dams.

At times, the effects of such phenomena are worsened by the effect of human actions on our environment. These can include:

- The waterproofing effect of laying tarmac on large surface areas of land.
- Cutting down trees and crops, leaving the land bare and facilitating erosion.
- The practice of channelling water, which can worsen flooding by increasing the quantity of water which flows into rivers in short periods of time.
- The building of constructions in rivers or waterways.

Flooded land can lead to landslides and the **collapse of buildings** if their structures have not been efficiently designed to withstand land movements.

Other possible types of **water damage to buildings** are those resulting from rain, hail or snowfall on the roof. Damage caused by these phenomena includes leaks, burst water pipes or drains, collapsing roofs, smashed skylights and windows, and so on. Aside from building damage, there may also be damage to the stored goods, which could prove costlier than that to the building itself.

In addition to the above, it is important to remember that flooding can cause **environmental pollution** by damaging stored goods and then carrying hazardous substances into the public water supply system. High temperatures can also cause products to decompose and they may then be carried by the flowing water, causing contamination of land or natural waterways.

To prevent environmental and other damage occurring (such as that to stored goods), warehouses can be fitted with sloping floors and underground drainage for the collection of water. If drains are connected to the general sewer system, the possibility of water entering the warehouse from the sewer system must be considered. This can occur due to the sewer system becoming blocked or overflowing. The best solution to prevent this is to install a sewer backflow valve in the warehouse drainage collector.

Flooding can also cause damage to the stored goods, including the packaging. This presents problems for electronic goods such as cameras or mobile telephones, where water damage to the packaging can affect product quality or even destroy the items.

To prevent **damage to goods**, it is advisable to place them in an area which is least exposed to such risks. In buildings with several floors, goods should be stored on the upper floors. Under no circumstances should warehousing facilities be located in basements. Another way to prevent or reduce water damage is to store products on pallets, boards or blocks which hold them at least 10 cm above floor level.

As regards water damage to buildings, a number of preventative measures can be adopted, including the following:

- Construction measures aimed at containing and transporting water in a controlled manner, such as walls or drainage channels around the building.
- Measures to elevate structures and buildings. These should be considered at the building design stage.
- Waterproofing and/or the sealing of openings in the building structure, such as doors and windows.

Water which enters buildings in an uncontrolled manner can affect machinery and stored goods. For this reason, it is important to keep the goods 10 cm or more above floor level. This can be done by stacking the goods on wooden or plastic pallets rather then directly on the floor, thereby can reduce possible damage due to rain, leaking pipes, and so on.

Most damage to buildings or goods is preventable by proper maintenance of roofs, ceilings, drainpipes and drains. Periodic checks and controls should be introduced and special attention should be paid to maintenance during periods when such damage is more likely, for example, in periods associated with heavy rainfall.

Roofs can collapse due to structural faults resulting from poor design or an excessive accumulation of hailstone or snow on the roof. This is particularly likely in the case of flat roofs or at the junction of buildings of different heights, where snow or water can accumulate.

Proper design of sloping roofs and guttering plus suitable maintenance of guttering and drainage systems are the only ways to prevent damage occurring.

3.3.3. Lightning strikes

Lightning produced in storms is directly or indirectly responsible for frequent harm to persons and damage to goods. Among the most common types of damage caused to warehouses are:

- Perforation of electrical installations.
- Fire and dangerous sparks.
- Damage to highly sensitive computer or electronic equipment.

An electrical storm

Although natural hazards are in general unpredictable, statistical data is available from lightning-strike records and it can be used to make risk estimates. It is possible to predict if a particular geographical area is at risk of suffering a lightning strike to a greater or lesser degree.

Lightning protection systems are based on a simple concept which involves intercepting the lightning before it strikes a specific object so that the current can enter or leave the ground without causing harm to people or damage to objects in its path. This is possible thanks to the use of pointed air terminals which allow the electrical current to travel easily along their length and to be discharged by this route.

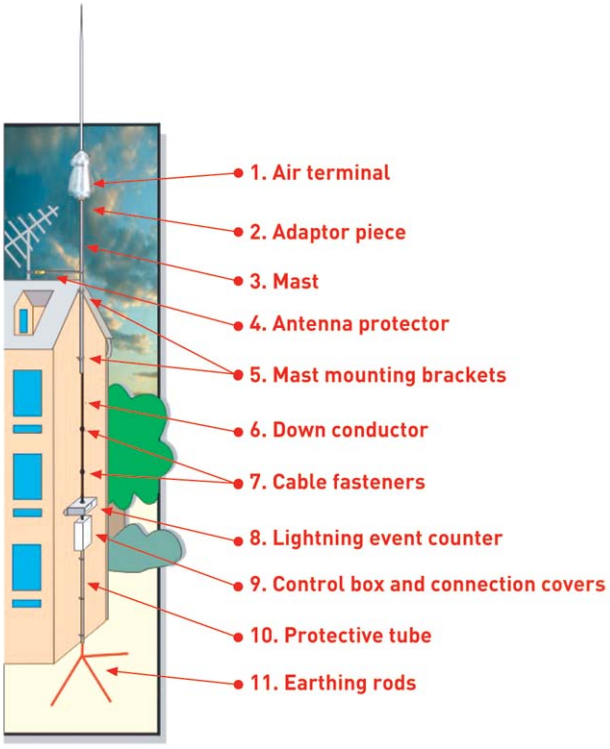
Such systems must be installed in all buildings where toxic, radioactive, highly flammable or explosive substances are stored or handled, as well as in any buildings higher than 43 m.

In other cases, the need for a lightning protection system is evaluated by estimating the lightning-strike rate and comparing it to the risk level of the building requiring protection. Consideration must be given to the type of construction, its use, occupation rate and the activities performed in it. When the estimated strike rate is higher than the acceptable risk level, a lightning protection system must be installed.

The basic elements of lightning protection systems and the requirements which should be fulfilled to ensure effective installation are the following:

- **An air terminal** installed on the warehouse roof. It must extend a minimum of 2 m above the highest point of the structure to be protected. The zone of protection must be such that even the most vulnerable point of the warehouse falls within it, within a maximum radius of 100 m. The zone of protection must be guaranteed by the manufacturer.

- **Down Conductors**. These are made of metal, principally copper, and allow the electric current to travel down from the air terminal to the earth connection. They must lead as directly and vertically as possible to the ground and, in addition, special care should be taken to ensure their proper maintenance and to avoid knocks and electrolytic corrosion.



Lightning rod with feeder device (Source: CIRPROTEC)

- **Earth connection**. This is comprised of a set of earthing rods of suitable diameter and with the lowest possible electrical resistance level (ideally 10 ohms). They must be connected to the main earthing system for the site where the warehouse is located.

All systems require annual checks and further checks immediately following any lightning discharge because poorly maintained systems or ones with defective components entail greater hazards. For this reason, the installation of a **lightning event counter** is essential to verify lightning strikes and therefore allow the necessary system checks to be carried out immediately.

Naturally, the most important factor when installing a lightning protection system is to ensure that it provides adequate **cover** for the buildings to be protected. This may be easier to verify at the initial building design stage. It must also be given careful consideration when expanding the warehousing facilities since the existing system may not provide sufficient protection for the expanded facilities. In such cases an accredited installation company should be asked to check the system and issue a certificate proving that it provides adequate protection against lightning strikes.

3.4. Theft and intrusion risk

Theft and intrusion are other risks to which warehouses are exposed.

As regards the **risk of intrusion**, this can have highly damaging consequences for warehouses in the form of **arson** or **intentionally setting fire to property**. Warehouses have high combustible loads and are therefore prime targets for such crimes, particularly when there are no people in the building. The reasons are wide and varied and experience shows that personal grudges or revenge can play a part.

As for theft, although it exists as a risk factor in all warehouses, assessment of the degree of risk it varies from one warehouse to the next. In general, two key factors require consideration:

- To what degree are the products attractive to thieves?
- Theft **vulnerability** or the ease with which the goods can be stolen.

To estimate the first factor, it is necessary to know the value of the stored goods:

- What is their market value?
- Can they be sold or placed in the market easily?

As regards the vulnerability of the goods, one must first know who to protect the goods against:

- Someone external to the company?
- Company staff?
- Someone external with help from inside the company?

Next, an assessment must be made of the ease or difficulty involved in transporting the products. Valuable goods that are heavy or difficult to transport are not as attractive as those that are easily transported.

Finally, the warehouse surroundings require assessment. Location in an unpopulated area is quite different to location in an urban environment. The risk of suffering a theft which cannot be prevented is greater in the first case than in the second.

In short, product vulnerability to theft is evaluated according to the **time factor**, which refers to the time necessary to delay the intrusion or the reaction time after an alarm is set off.

The anti-intrusion and anti-theft measures employed in warehouses to reduce risk to acceptable levels can vary as widely as the products stored in them. For this reason, providing an exhaustive list of valid protection measures for all warehouses is not feasible here.

Protection systems need to be looked at on an individual basis, selecting the most suitable measures according to each risk and according to the minimum level of protection necessary. However, general recommendations can be divided into the following categories:

- Passive protection measures intended to delay intrusion.
- Active protection measures intended to detect the intruder and raise the alarm in the event of intrusion.
- Organisational measures, which include the relationships between the agents involved in intrusion protection.

Choice of the most appropriate anti-intrusion protection system requires careful balancing of the three types of measures outlined above.

3.4.1. Passive protection measures

Lockable metal shutter warehouse door

Folding metal door

In general, thieves want to break into warehouses and escape with the stolen goods as quickly as possible. The main aim of passive protection measures is to delay entry into the warehouse for as long as possible.

Access is usually gained through openings in the structure of the building, such as doors or windows. Implementing suitable security measures in these areas can be one of the most simple and effective ways to prevent thefts in warehouses.

Door locks should be sturdy and preferably made of steel. However, such locks frequently will not resist a break-in attempt involving metal cutters or hydraulic jacks and, therefore, additional security measures must be adopted.

Industrial buildings used as warehouses often have large folding metal entrance doors or sliding metal shutters over doors where vehicles enter and exit to carry out merchandise loading and unloading. Such doors usually have a hook or catch on one side to secure the door but often they do not have fitted locks or padlocks. In such cases, it is advisable to install such devices and, if possible, a locking device in the central part of the door or gate to ensure that it is secure.

Security padlock

Sometimes these entrances also incorporate a smaller door for people to enter. Another sturdy lock should be installed here.

Access door for people

Although door and lock security is important, **controlling the keys** is equally important. If anyone can obtain access to the keys, the locks are useless. A recommended security measure is to keep keys in a place with access restricted to individuals authorised by the company management team. It is advisable to keep a record of all individuals who have access to keys and, in addition, locks should be changed as often as deemed necessary in order to maintain warehouse security.

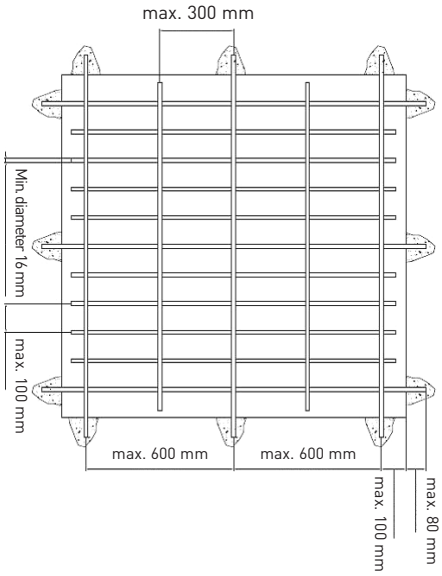
Windows and skylights constitute another opening which thieves can use to break into warehouses. Windows must have a secure lock fitted, along with reinforced safety glass.

However, the best option for delaying access through such openings by a thief is the installation of **window bars**, preferably on the outside rather than on the inside. This protection measure is recommended for both windows at street level and on higher floors, as well as for skylights in roofs.

Window bars

Window bars should be made of solid steel, be embedded or anchored to the wall and be the

correct size in order to prevent access to the premises.



Recommended measurements for window bars

All possible access routes to the building must be made secure. This includes emergency staircases leading to access doors and even peripheral fences and gates.

3.4.2. Active protection measures

Active or electronic protection measures are those intended to detect and raise the alarm if any intrusion into the premises takes place.

External emergency staircase

Peripheral fence with sliding gate

Anti-Intrusion protection in warehouses is often based on the use of **presence detectors**, particularly **passive infrared detectors**. These detectors analyse an infrared image of the premises and react in the event of temperature differences caused by a potential intruder in the protected area.

Presence detector

They are generally installed in rooms, corridors or transit areas and are located near the openings through which an intruder will probably enter, such as doors, gates and windows. Failure to protect these points would result in a failure to detect intruders using these means of access.

Sometimes additional protection is introduced to complement the presence detectors. This involves the installation of **magnetic contact sensors on doors and windows**. These are based on the activation of an alarm when the two halves of the detector are separated. When the door or window in question is opened, the two halves of the detector (one is attached to the frame and the other attached to the door) are separated and the alarm signal is activated.

It should be noted that such detectors will only be activated when the door or window is opened and not when the glass is broken. Therefore, they should be combined with breakage sensors or, as is more common, the use of indoor presence detectors located near the window.

This is also the case with intrusion which takes place as a result of making holes in the walls of adjacent buildings or in concealed places on the outside of the premises. For this type of intrusion the most effective protection measure involves installing vibration or seismic sensors in the walls, floors or ceilings which are most vulnerable to this risk.

Active protection measures must be combined with an **alarm** connected to an **alarm reception centre**. The volume and duration of the acoustic signal must

comply with current legislation, which is generally contained in local ordinances applicable in the town or region where the warehouse is located.

Connection to the alarm reception centre must be by means of a system which guarantees communication between the alarm signal and the reception centre. This type of transmission can be achieved via a Switched Telephone Network (STN) or by a Global Mobile System (GMS), which is the standard communication system between mobile telephones. Further protection may be achieved by using an additional system which lies dormant until required. Such a system will activate in the event of sabotage or malfunctioning of the line and will guarantee that an alarm signal is still sent to the reception centre.

Despite the protection offered by the above systems, one should still keep in mind that when the alarm has been set off, the intruder is already inside the premises and has a time window which may be sufficient to enable the theft of items of considerable value.

3.4.3. Organisational measures

Organisational measures comprise all relationships between the various agents, particularly people, in charge of ensuring the implementation and proper operation of the security measures.

If it is obvious that someone is watching, it is unlikely that thieves will think that they can carry out a robbery and escape with stolen items. Therefore, surveillance is considerably effective as a protection measure.

Formal warehouse **surveillance** is carried out by professional security staff such as police officers or security guards and, in some cases, it also involves the use of **Closed Circuit Television Cameras (CCTV)** to record images.

Informal surveillance can be provided by company employees who are suitably trained in the performance of such tasks and in the procedure to be followed in the event of intrusion.

In warehouses where employees work round-the-clock in three shifts during the whole year, sufficient protection may be offered by locating a security station at the site entrance to control staff access and, in addition, designating employees with responsibility for informal surveillance.

In the case of warehouses with a high risk of theft and intrusion, a suitable system of protection is provided by having a security station at the entrance to control access during the working shift and a surveillance service during inactive periods, incorporating scheduled security patrols and possibly combined with monitoring by CCTV cameras.

A good way to encourage informal building surveillance is to install adequate **external lighting**, either permanent or connected to a motion sensor which will turn on floodlights when people approach the building. External warehouse lighting is generally an effective deterrent to potential intruders since most thefts occur at night.

Another aid to surveillance involves maintaining good visibility conditions in the warehouse surroundings by eliminating obstacles that may offer thieves a place to hide from surveillance measures.

As regards the risk of arson by an external intruder, the most effective protection measures are continuous control of site access and adequate maintenance of automatic protection devices to ensure that they function correctly in the event of an intentional fire.

> 04 Conclusions

The volume of goods stored in warehouses means that the material losses suffered in the event of a fire can be considerable. In addition, damage to professional image may occur, which hinders recovery and the achievement of a return to normal business activity. As a consequence, the warehousing sector is highly sensitive to fire risk and adequate protection requires exceptional safety measures which may even surpass those required in law.

However, risks are not limited to those related to fire. It is also important to protect warehouses against theft, natural catastrophes and environmental damage that may be caused by stored goods.

Given the wide range of potential threats, warehouse safety management requires corporate managers to have a comprehensive vision of risk. In addition, the company must have a proper maintenance policy for its warehousing facilities and the best housekeeping and cleaning practices must be followed. The existence of a safety management policy alone will be of little use unless it is complemented by the involvement of all parties. Naturally, leadership is essential in order to achieve good results in this area. Managerial actions and decisions send clear messages to all levels of the organisation regarding which actions are considered important and which are considered unacceptable.

The principal purpose of a well-designed and adequately maintained warehouse is to ensure that the receipt, protection and dispatch of goods are carried out as efficiently as possible. To achieve this goal, the important requirements do not only include factors such as location near the final customer, ease of transport, flexible storage spaces and proper sizing of the warehouse. It is also vital to guarantee the **safety** of the stored goods and in doing so, of the warehouse itself.

For this reason, warehouse **safety** represents an added value in the services offered to clients.

Appendix

HOT WORK PERMIT (1)

CODE: INTERNAL CONTROL:	PERMIT VALIDITY (DATE/TIME): FROM: _ _ / _ _ / _ _ _ _ _ _:_ _ TO: _ _ / _ _ / _ _ _ _ _ _:_ _

TO BE COMPLETED BEFORE WORK COMMENCES

1. PERSON REQUESTING THE WORK

Description of work:

Location:

Expected date: _ _ / _ _ / _ _ _ _

Person requesting the work:
.....

Signature:

Position in the company: .....
Date: _ _ / _ _ / _ _ _ _

2. PERSON RESPONSIBLE FOR AUTHORIZING THE WORK

a) Shall ensure compliance with contractual guarantees (in the case of subcontracted companies) and internal safety regulations.
b) Shall authorize execution of the work only if the minimum safety precautions are observed. (COMPLETE CHECKLIST).

WHO WILL PERFORM THE WORK?

	YES	NO
Own staff:	☐	☐
Subcontracted staff:	☐	☐

Company (in the case of subcontracted staff):
.....

Person authorizing the work:
.....

Having completed the corresponding safety condition checks, I hereby AUTHORIZE execution of the work for the period of validity specified above.

Signature:

Position in the company: .....
Date: _ _ / _ _ / _ _ _ _

3. PERSON PERFORMING THE WORK

a) Shall have the authorization signed by the Person Responsible for Authorizing the Work before work commences.
b) Shall stop performing the work if the safety conditions change, immediately notifying the Person Responsible for Authorizing the Work.
c) Shall comply with internal and external safety regulations, in addition to any additional instructions issued.
d) Shall verify that the minimum safety precautions are observed (SEE CHECKLIST).

Person performing the work:.....

Signature:

Position in the company: .....
Date: _ _ / _ _ / _ _ _ _

BEFORE WORK COMMENCES, CHECK THAT ALL THE CHECKLIST SAFETY CONDITIONS ARE COMPLIED WITH!

TO BE COMPLETED AFTER THE WORK HAS BEEN CARRIED OUT

4. FINAL CHECKING

The working area and any adjacent areas which may have been affected by sparks, flames or heat transfer (including upper or lower floors and the opposite side of the wall to where the work was performed) have been inspected at least once in the hour following completion of the work, verifying that no latent fires are present.

Date and time the final check was completed: .....

Person performing work:	**Person authorizing the work:** .....
Signature:	**Signature:** .....
Position in the company:	**Position in the company:** .....

DELIVER COPY TO: The PERSON REQUESTING THE WORK, the PERSON PERFORMING WORK and the PERSON AUTHORIZING THE WORK

(1) "Hot work" refers to all operations generating heat, sparks, flames or high temperatures, whether near or far from flammable or combustible dust, liquids or gases, or containers which contain or have contained such products. Operations of this type include, for example, soldering, oxycutting, grinding, drilling, and so on.

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CHECKLIST

(TO BE COMPLETED BY THE PERSON RESPONSIBLE FOR AUTHORIZING THE WORK)

BEFORE WORK COMMENCES	YES	N/A[1]	COMMENTS
1. Ensure that the work area has been cleared and is free of all flammable or combustible materials within a radius of at least 10 m.			
2. Ensure that there are no combustible or flammable materials in areas below the work area.			
3. Ensure that all combustible or flammable materials that cannot be removed have been protected against flames, heat and sparks.			
4. Ensure that openings in walls and floors and/or the area located below the work area are protected against flames, heat and sparks. 5. Ensure that manual fire extinguishers (and fire hose cabinets, if present) are adequate, in good working condition, visible and accessible from the work area.			
6. Ensure that the equipment used to perform the work is safe and has been checked and found to be in good working condition.			
7. Ensure that the necessary collective and personal protective equipment is available.			
8. Ensure that any possible explosive atmospheres caused by flammable vapours, gases or combustible dust have been eliminated.			

Date: ..... **Time:** .....

[1] N/A: Not applicable

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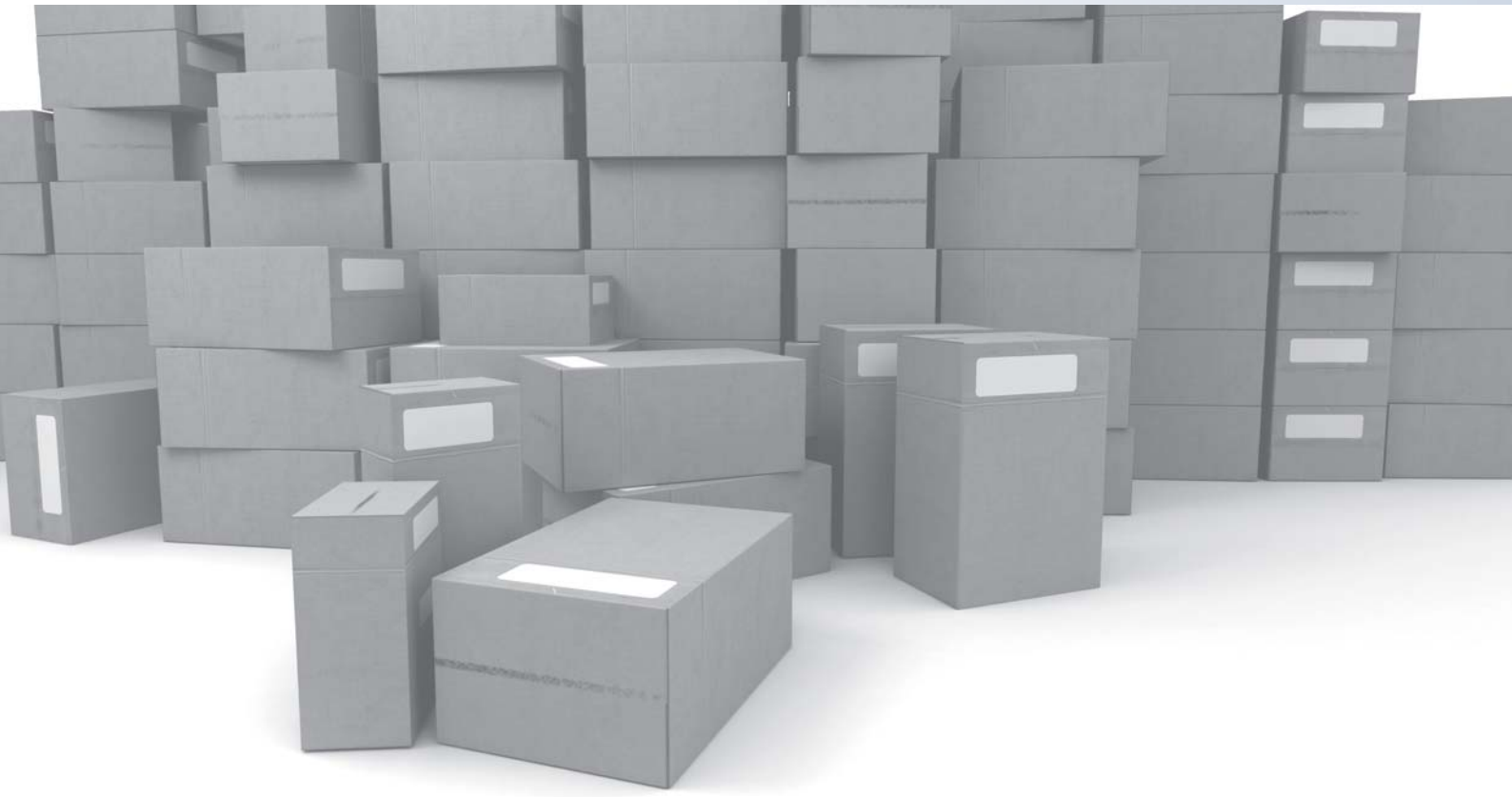

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