FIRE LOSS
PREVENTION
FORUM OF INDIA

LOSS PREVENTION IN WAREHOUSES

NOVEMBER 2020

CONTENTS

Disclaimer: The technical recommendations for loss prevention in specific areas are a result of the discussion during the Fire Loss Prevention Forum of India (FLPFI) meeting held in November 2019. The recommendations shall not be taken as replacement to detailed recommendations provided in the standards (FM Global Property Loss Prevention Data Sheets).

1. EXECUTIVE SUMMARY

Warehouses of today in India, which used to be dilapidated buildings called godowns a few decades ago, have now become the backbone of manufacturing and e-commerce industry. The main purpose of this white paper is to raise awareness on the critical elements which must be considered when developing a comprehensive risk mitigation strategy to protect warehouses and ultimately to ensure businesses are remain resilient. This report is based on presentations given at the 5th Fire Loss Prevention Forum of India meeting. It includes summaries based on representations from companies renowned as global experts in the fields of property insurance, logistics, and warehouse fire safety. We hope this paper provides a better understanding of the many fire safety aspects to consider in order to better-protect warehouse and storage facilities.

2. INTRODUCTION

The logistics sector is fundamental to a country's development; its performance providing a key indicator to a nation's overall fiscal position. In India, global investment, government reforms and technological innovation has contributed towards a huge transformation in its logistics sector. A CARE credit rating agency report states the country's logistics sector has a $215 billion market worth, whilst estimates the number of people employed in the industry will surge to 44 million in 2020.

Warehousing has a vital part to play if India's logistical market is to continue to thrive. In these busy industrial environments, managing risk in terms of fire assumes the highest priority. Without such measures it could leave companies vulnerable to loss of life and operational inefficiency. Profit margins, as well as reputation – the importance of which should never be underestimated – are also under threat if the highest fire safety standards are not meticulously enforced.

This paper looks at the whole issue of fire safety in India's warehouse sector and outlines how sprinklers can play a significant role in saving life and property from the devastating effects of fire. It is hoped the information contained within this paper will help provide a clearer picture of the issues that need to be considered in order to ensure India's logistics industry continues to flourish without compromise to the safety.

3. LOGISTICS AND WAREHOUSING SITUATION IN INDIA

Warehousing constitutes only 15-35% of the total logistics costs, but its importance is significant in respect to the role it plays in the smooth functioning of supply chain networks. It is the efficiency of a businesses' logistics and distribution machinery that dictates their reach, time to market and cost efficiencies which prove to be a big factor enabling businesses to stay relevant in today's ultra-competitive environment. This is especially true in the internet age where businesses are forced to constantly cut costs to acquire or retain consumers.

Logistics costs in India account for between 13 and 17% of the Gross Domestic Product (GDP) which is nearly double (6-9%) the logistics cost to GDP ratio in developed countries such as France, Hong Kong and the U.S. The need to quantify the size of the Indian warehousing opportunity was outlined in a report carried out by Knight Frank, the UK's leading independent real estate consultancy. It estimated the total requirement of storage space in the Indian manufacturing sector that accounts for 80% of the current warehousing market.

The in-depth study included the accounts of listed and unlisted entities in the automobile, auto ancillary, cement, chemicals, pharmaceutical, textile, fertilizer and agrochemical, Fast Moving Consumer Goods (FMCG), Fast Moving Consumer Durables (FMCD),engineering and metals industries and delved into their logistics cost components. The information helped refine the estimations of value committed towards their warehousing needs. It resulted in leading manufacturing companies allocating 0.22% to 2.03% of net sales for warehousing: engineering (0.22%); metals (0.24%); auto-ancillary (0.35%); textile (0.36%); consumer durables (0.38%); automobile (043%); pharmaceuticals (043%); fertilisers and agrochemicals (046%); chemicals (0.57%); FMCG (0.80%); cement (2.03%).

Based on these specific industry allocations, the report estimated a total warehousing space requirement of 68mnm^2 (739 mnft^2) for 2019, will grow at a compounded annual growth rate (CAGR) of 5% in the next five years to 86mnm^2 (922mnft^2) in 2024. Hence, over the following five-year period, an incremental 17mnm^2 (183mnft^2) of space will be required by the Indian manufacturing sector.

Separately, the Guidehouse insights (previously known as Navigant research) estimated that the warehousing space requirement of 622,372,254 ft^2 for 2019, will grow at compounded annual growth rate of 3.2% in the next 10 years to 823,514,614 ft^2.

Ecommerce and Third-Party Logistics (3PL) has seen a massive growth in warehouse space take-up in 2018, followed by manufacturing and retail sectors e.g: 3PL space take-up has increased from 7.5$mnft^2$ in 2017, to 16.8$mnft^2$ in 2018, resulting in 122% year-on-year growth. In 2017, Ecommerce recorded a 3.9$mnft^2$ space take-up. This increased to 11.1$mnft^2$ in 2018, which represented a 184% year-on-year increase. FMCG, FMCD and retail occupiers have been increasingly outsourcing their warehousing requirements to 3PL players.

The 3PL and ecommerce players continued to dominate India's warehouse space take-up during 2018: 3PL (36%); ecommerce (24%); manufacturing (24%); retail (11%); FMCG (4%); FMCD (3%); others (1%).

The government of India recently released the draft framework of its inaugural logistics policy. The primary aim of this policy is to enable integrated development of the logistics sector in India. Despite being a key economic driver, the industry suffers from ineffectiveness and wastages leading to high costs. Logistics costs in India, as a percentage of GDP, is as high as 13%-14%, while its global counterparts stand at 8%-10% of GDP. The primary reason for such costs is the highly-disorganised nature of this industry and highly-skewed multi-modal mix. Approximately, 60% of freight movement in India happens via road, which is significantly higher than most developed economies. Globally, the share of rail cargo in the multi-modal mix is higher. Further, different parts of the logistics value chain are currently being managed by numerous departments and ministries. The result of these multiple hurdles is increased inefficiencies in the logistics industry.

In total, 83% of the USD 6.8bn invested into warehousing is committed by the institutional investors alone and is estimated to create more than 15mnm^2 or 158$mnft^2$ of new warehousing space.

Global outlook – weathering and logistics industry

Whilst compared to global logistics cost, India's logistics cost is high, therefore the competence ranking is low. The country's logistics itself is undergoing a huge transformation due to the influence of global players, government reforms and technological modernisation. Traditionally, sectors were fragmented. A process that was exacerbated by disorganised intermediaries, Indian companies controlling supply-chain functions, dispersed services, low sophistication and infrastructure bottlenecks.

Recent trends have seen the emergence of organised players in the form of multi-national companies. This has been critical in highlighting the need for efficient supply chain management and outsourcing. Integrated, end-to-end 3PL services have also aided the transformation process, along with technology advances and governmental reforms.

Future progress will depend upon the consolidation of warehouses, whilst improved technology will help streamline operations by reducing the role of the 'middleman'. Automation in the form of robotic or AI intervention will reduce logistics time and costs.

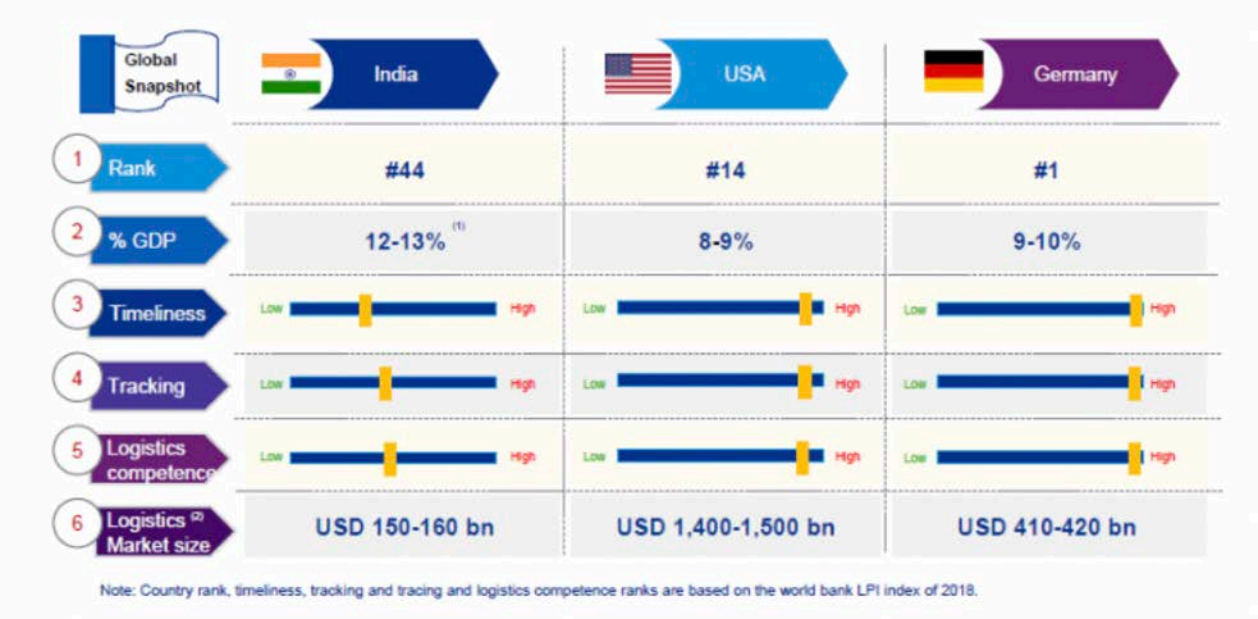


Table courtesy of Indospace, India's largest industrial and logistics parks developer

4. FIRE HAZARDS AND LOSS EXPERIENCES IN WAREHOUSES

Warehouses are often encompass large open spaces occupied by only a few people. With few occupants in the area, fires in the incipient stage may go undetected for an extended time period, particularly in spaces not protected by automatic fire detection and/or suppression systems. Common hazards and ignition sources generally associated with warehouses are hot work operations, failure of electrical equipment, incendiarism, careless disposal of smoking materials, and ignition from material handling equipment.

Apart from ignition, fuel is another 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. This is where the nature of goods or materials stored is of most importance, as it will affect how quickly a fire spreads.

The severity of a fire will depend on the combustibility of the material. Plastic and synthetic materials generally tend to burn more quickly than ordinary or natural materials such as cardboard. Therefore, there is a need to differentiate between stored goods and materials.

Type of storage is an influential factor in the cause of fire ignition and spread. Generally, indoor warehouses are designed with a specific storage capacity. However, financial considerations mean that the storage space is optimised, leading to high stacks with minimum separation distances between them and sometimes, the accumulation of large quantities of material in one area.

In addition to the factors outlined above, other elements 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:

1. The existence of important electronic or precision equipment.
2. The presence of documents or files of high strategic value to the company.
3. Products liable to suffer damage due to combustion gases or as a result of environmental conditions producing rust.
4. Luxury or valuable goods.
5. 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 etc.

Fire protection measures installed at a premises influence the ability to control fires and to extinguish them with minimal consequences. Metallic structures without additional protection against fire are not advisable. Steel begins to become unstable when subjected to temperatures above 538ºC, even if only for a few minutes. Heat deformation of the structure could lead to issues such as roof collapse and fire protection pipe installations fracturing. The resulting water loss will lead to the fire protection installations malfunctioning, leaving the 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. In 'normal conditions', a fire spreads in two directions: horizontally 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.

The best means of preventing building damage is to control and suppress the fire through the presence of active protection measures such as automatic sprinkler installations. Fire risk can also be reduced by ensuring safe distances specified for manual fire protection systems are not increased in relation to the layout of storage space and goods. The safe distances for any specified are 30m to the nearest fire hose cabinet; 30m to the nearest alarm button; 15m to the nearest extinguisher containing suitable extinguishing agents. It is also crucial to ensure extinguishers are not obstructed by loading equipment.

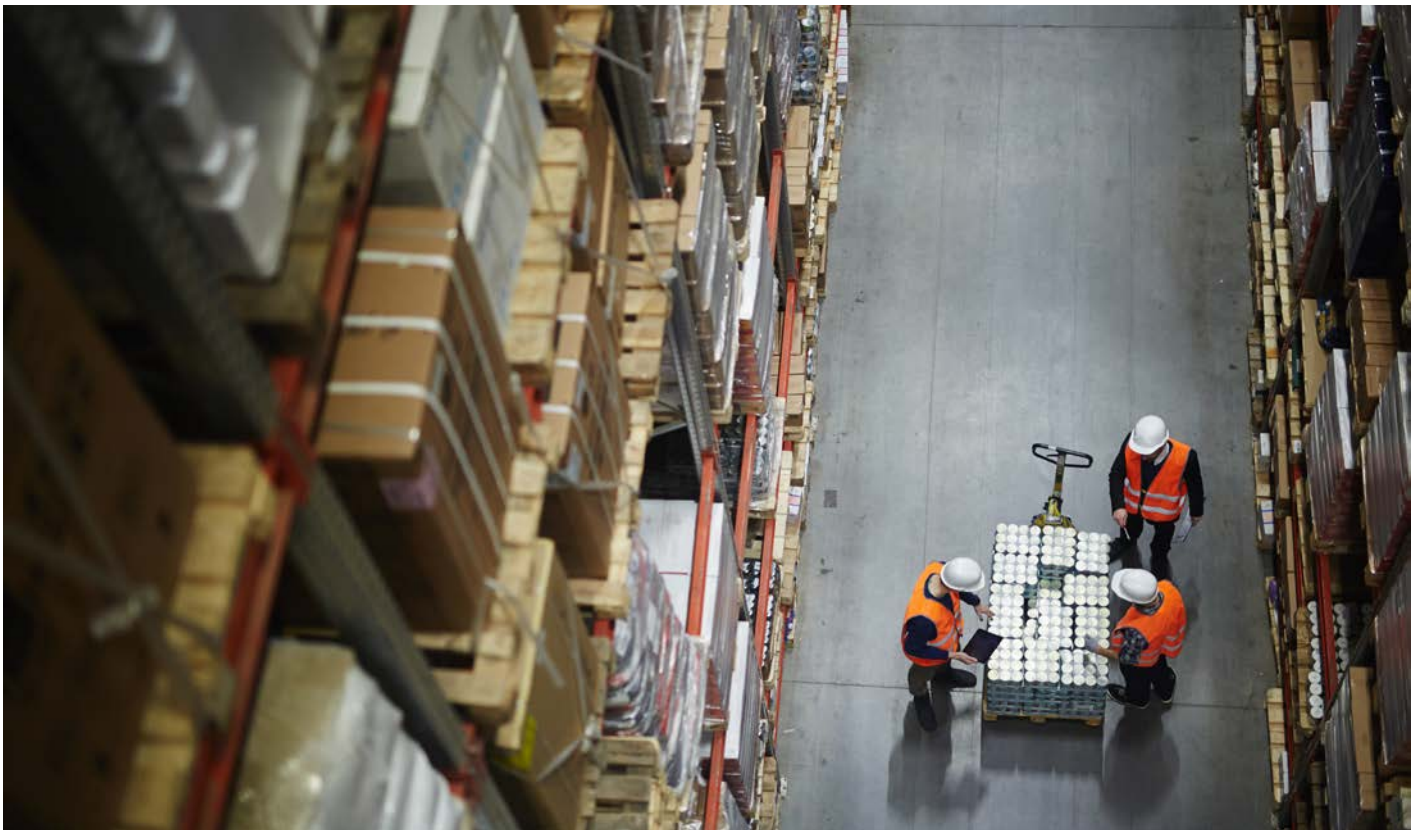
Further, maintenance of fire protection equipment and installations must be carried out in accordance with the regulations in relation to Fire Protection Installations. Additionally, it's vital to develop an updated and correctly implemented emergency plan that incorporates training activities involving real fires and annual fire drills.

Warehouses represent a unique fire challenge to both fixed fire suppression systems and the manual firefighting forces that are called upon to deal with a fire. Modern warehouses and storage occupancies are especially subject to rapidly developing fires of great intensity, because complex configuration of storage and building layout are usually conducive to fire spread, presenting numerous obstacles to manual fire suppression efforts. The only proven method of controlling a warehouse fire is with properly designed and maintained automatic sprinkler systems.

5. STORAGE CONFIGURATION AND COMMODITY CLASSIFICATION

The Fire hazard of a warehouse or storage occupancy is a function of the commodity or the material in storage, the method of packaging, and the storage arrangement. Fire development in storage area depends on the material, ease of ignition, flame spread rate, and the heat release rate. Often a judgment concerning the hazard of the storage is based on the commodity with little thought given to the methods of packaging and the storage arrangements. For example, a metal part stored on wooden pallet poses a low threat of fire. However, if the same part is packaged inside a multilayer cardboard carton with expanded polystyrene foam packaging material, the fire hazard is greatly increased. Plastics are increasingly used as part of the product as well as packaging.

Typical definitions of FM Global's storage arrangements and commodity classifications can be found at Appendix A. Protection guidance for these can be found in FM Global datasheets, Indian standards or other internationally recognized standards.



6. LEGISLATION AND CODE OF PRACTICES

National building Code 2016 (Part 4) is the legislation and IS 3594 and IS 15105 are the code of practices that guides and defines fire safety requirements for warehouses and storage buildings in India.

The definition of storage and warehouse buildings is outlined in part 4 of the National Building Code (NBC) - Group H occupancy: these shall include any building or part of a building used primarily for the storage or sheltering (including servicing, processing or repairs incidental to storage) of goods, ware or merchandise (except those that involve highly combustible or explosive products or materials) vehicles or animals. For example: warehouses, cold storage, freight depots, transit sheds, storehouses, truck and marine terminals, garages, hangers, grain elevators, barns and stables. Storage properties are characterised by the presence of a relatively small number of persons in proportion to the area.

Table 7 of NBC indicates the minimum fire protection requirements for Group-H Storage buildings. It mandates sprinkler protection for storage buildings and gives reference to IS 15105 for design and installation.

IS 3594 is the code of practice relating to fire safety of industrial buildings: general storage and warehousing including cold storage – includes fire safety guidance in relation to a building's location; the type of building construction; a building's maximum height; the means of exit, and compartmentation. This standard also covers guidance with respect to ventilation, smoke vents, storage heights, aisles and passageways, mechanical handling of equipment and machinery, and housekeeping.

IS 15105 is the installation and design standard for sprinkler systems. The current version of the standard is of 2002 and it was taken up for comprehensive revision based on good international practices. The revised standard is currently under publication and is expected to be published by the end of 2020 by Bureau of Indian Standards. This standard gives guidance on selection of sprinkler type, pattern, and other sprinkler characteristics, such as K-factor, temperature, sensitivity, etc based on hazard category of building. This standard also specifies design density requirements for sprinkler system for a given commodity category, storage configuration and height of ceiling and storage. It also specifies guidance on installation features, such as location and orientation of deflector to avoid obstructions to obstructions, spacing between sprinklers, etc.

Fire safety requirements of warehouse and storage buildings in India are governed by the following codes and standards:

- National Building Code of India, 2016
- IS 3594 – Fire safety of industrial buildings: General storage and warehousing including cold storages - Code of practice
- IS 15105 – Design and installation of fixed automatic sprinkler fire extinguishing systems – Code of practice
- IS 13039 – External hydrant systems – Provision and maintenance – code of practice
- IS 15325 – Design and installation of fixed and automatic high and medium velocity water spray systems – Code of practice
- IS 2189 – Selection, installation and maintenance of automatic fire detection and alarm systems
- IS 1646 – Fire safety of buildings (General) : Electrical Installations – Code of practice

The following FM Global Loss Prevention Data Sheets can also help reduce the risk of fire at warehouses and storage buildings. (link to download – fmglobaldatasheets.com)

- 2-0 – Installation guidelines for automatic sprinklers
- 8-1 – Commodity classification
- 8-9 – Storage of class 1, 2, 3, 4 and plastic commodities
- 8-29 – Refrigerated storage
- 1-10 - Interaction of sprinklers, smoke and heat vents, and draft curtains

7. PROTECTION OF SPECIAL STORAGES

Special storages such as aerosol products, ignitable liquids, rubber tires, energy storage systems, roll paper, automatic storage re-trieval systems etc, requires special attention in terms of protection requirements and in most of the cases there are no guidance available in Indian standards.

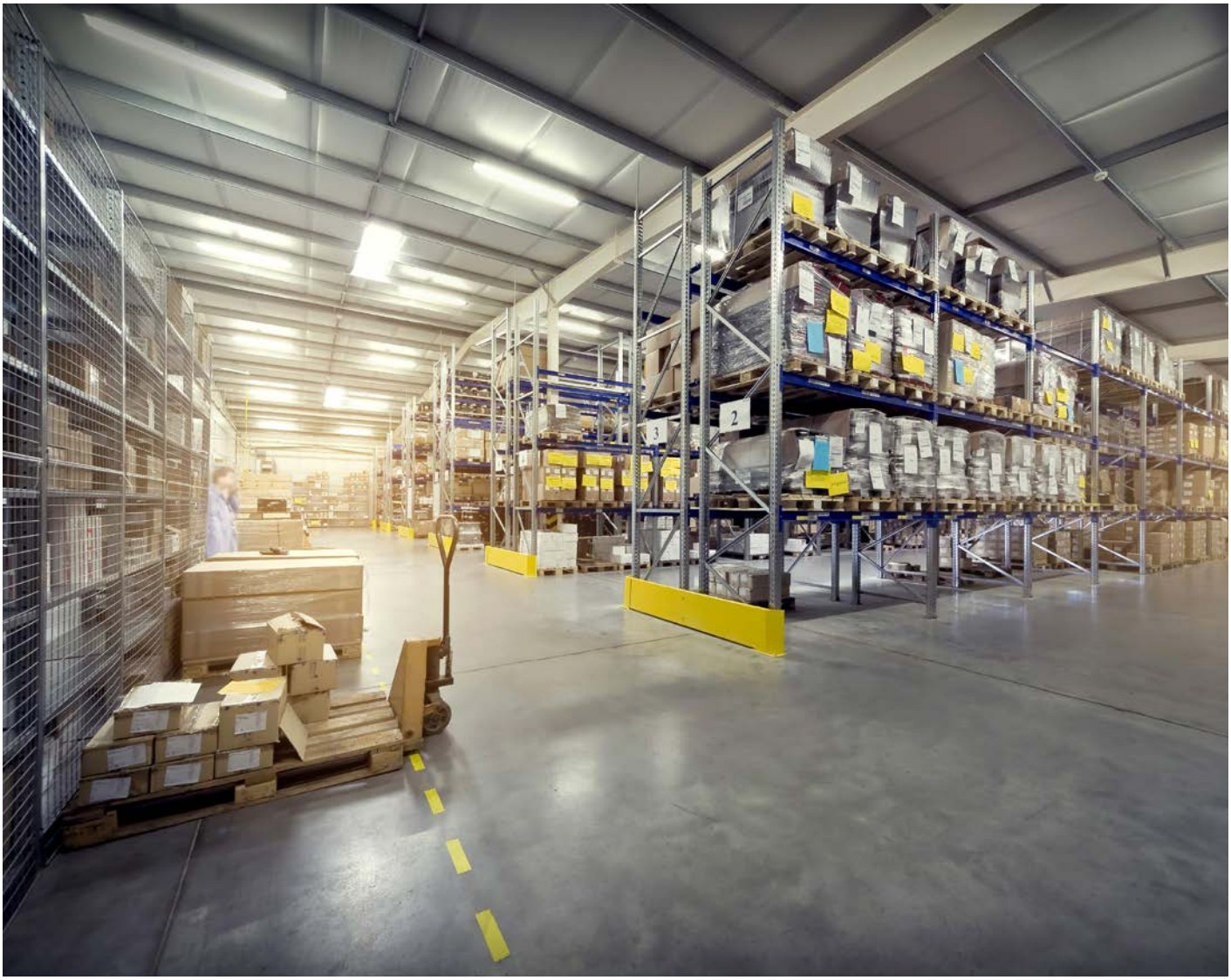
The following FM Global Property Loss Prevention Data Sheets can also help reduce the risk of fire in case of such special storages. (Link to download – fmglobaldatasheets.com)

- 5-33 Electrical Energy storage systems (for storage of individual Li-ion batteries, refer to 8-1)
- 7-29 Ignitable liquid storage in portable containers
- 7-31 Storage of aerosol products
- 7-75 Grain storage and milling
- 8-3 Rubber tire storage
- 8-7 Baled fibre storage
- 8-10 Coal and charcoal storage
- 8-18 Storage of hanging garments
- 8-21 Roll paper storage
- 8-22 Storage of baled wastepaper
- 8-24 Idle pallet storage
- 8-27 Storage of wood chips
- 8-28 Pulpwood and outdoor log storage
- 8-29 Refrigerated storage
- 8-30 Stroage of carpets
- 8-33 Carousel storage and retrieval system
- 8-34 Protection of automatic storage and retrieval system

8. WAY FORWARD

The group discussion during fire loss prevention forum of India meeting in November 2019 resulted in the following outcomes:

1. The whitepaper shall reach all state fire services departments in order to share the knowledge and information.
2. Indian Standard (IS 3594) shall be taken up for its revision as it is very old standard and needs a revision. The revision should address some of the challenges discussed in this whitepaper that are being faced by the industry and the warehousing developers in the country. The issue of revision will be taken up in the Fire Safety Committee, CED 36 of Bureau of Indian Standards.
3. Bureau of Indian standards will be requested to standardize the commodity classification of materials stored in the warehouse that contributes to the fire risk. This should be included in IS 15105.



9. APPENDIX A

Storage Arrangements

There are four types of storage arrangements. They are:

- Rack storage
- Solid piled storage
- Palletized storage
- Shelf storage

Rack Storage

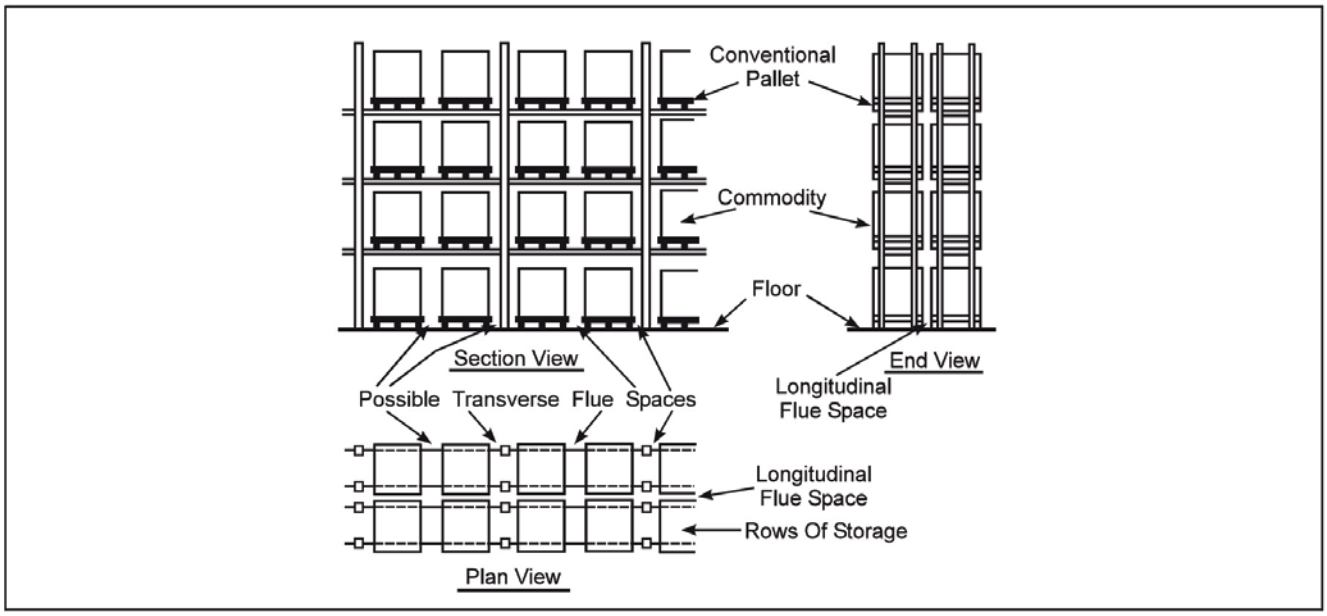
Rack storage is storage in racks that use a combination of vertical, horizontal and diagonal members to support stored material. Racks can be either open or solid, and may be fixed in place or portable.

The most commonly encountered forms of rack storage are:

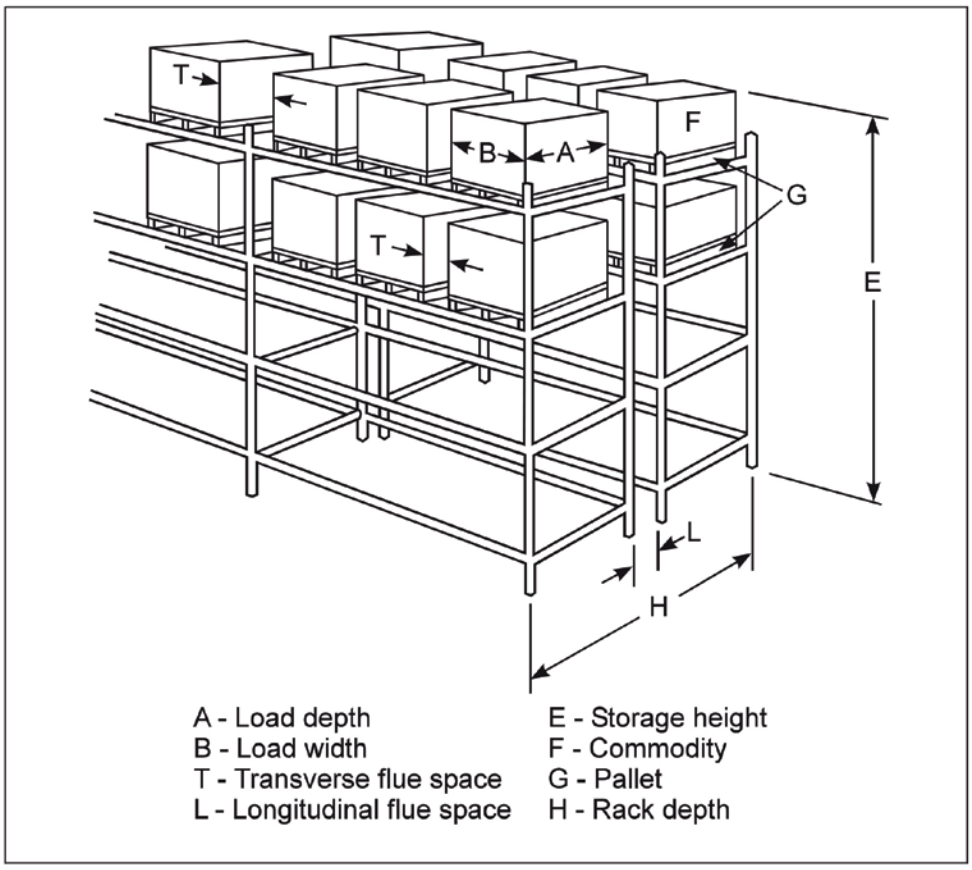
- Single-row racks have no longitudinal flue spaces
- Double-row racks are two single-row racks placed back to back separated by a longitudinal flue apace.
- Multiple-row racks are racks greater than 3.6m wide.
- Portable
- Movable

Flue spaces

The spaces between rows of storage are called flue spaces. In rack storage, the longitudinal flue spaces are perpendicular to the direction of loading, and transverse flue spaces are parallel to the direction of loading. The figures adjacent illustrate this.



Typical double row (back-to- back) rack arrangement'



Open-frame double-row rack

Tier

Each vertical segment of storage within a rack is called a tier.

Solid Shelving

Solid shelving is fixed, in-place solid, slatted (fixed or non-fixed) grated (less than 70% open, or other types of shelves located within racks that negatively impact the amount of sprinkler water that can reach the entire vertical length of the rack. Solid shelves in racks promote horizontal fire spread and obstruct sprinkler water penetration down through the racks.

Solid piled storage

This is on-floor storage, without pallets or other material handling devices. Unit loads are placed on top of each other, leaving no horizontal spaces between unit loads.

Palletized storage

This is storage on pallets. Pallet loads of storage are placed one on top of another, but are not stored in racks.

Shelf storage

This is storage on a structure where solid shelves are less than 0.8 m deep, measured from aisle to aisle, and usually less than 0.6 m apart vertically. A typical example is supermarket shelves.

Commodity Classification

Introduction

A commodity is the combination of the product, packaging material, container and material handling aids (such as pallets). The standard commodities are ranked from the lowest hazard to highest hazard, as follows:

- Noncombustible
- Class 1
- Class 2
- Class 3
- Class 4/Cartoned unexpanded plastics (CUP)
- Cartoned expanded plastic (CEP)
- Uncartoned unexpanded plastic (UUP)
- Uncartoned expanded plastic (UEP)

Non-combustible

Noncombustible materials do not burn and do not by themselves require sprinkler protection. Typical noncombustible materials include free-flowing powdered, inert materials such as:

- Metal pots and pans
- Glass bottles or jars, empty or filled with non-ignitable liquid
- Fresh fruit and vegetables – Not frozen
- Motors, electric, metal housing – tools and parts

Class 1

Class 1 commodities are described as:

(a) Noncombustible materials on wooden pallets
Noncombustible materials packaged in ordinary corrugated cardboard cartons, or in ordinary paper wrappings on wooden pallets.*

* Class 1 commodities may contain a negligible amount of plastic trim such as knobs or handles.

Examples of Class 1

Typical Class 1 commodities include:

- Noncombustible products stored on wooden pallets
- Metal cans filled with non-ignitable liquids – stored on cardboard trays
- Free-flowing inter material stored in combustible bags in racks (eg- Cement, calcium chloride, clay, iron oxide, sodium chloride)
- Metal parts stored in cartons

Class 2

Class 2 commodities are Noncombustible or Class 1 products stored in slatted wooden crates, solid wooden boxes, multiple thickness corrugated cartons, or equivalent combustible packaging material on wood pallets.

Examples of Class 2

Examples of Class 2 commodities are:

- Class 1 products in small cartons or packages, placed in ordinary corrugated cartons (e.g., boxes in boxes);
- Frozen solid food (e.g., prepared frozen meals on thin plastic trays and cartooned)
- Cartoned computer software packages, no plastic in packaging.

Class 3

Class 3 commodities are packaged or unpackaged wood, paper or natural fiber cloth, or products made from these materials, on wood pallets. This includes Classes 1, 2, and 3 products containing no more than 5% plastic by either weight or volume.

For example, metal bicycle frames with plastic handles, pedals, seats and tires are a Class 3 commodity since the amount of plastic is about 5% (metal frames with plastic handles only would be a Class 1).

Examples of Class 3

Examples of Class 3 commodities include:

- Books; magazines, newspapers;
- Tissue products in cartons;
- Shoes, jackets, gloves, luggage.
- Doors; windows; door and window frames

Plastics

Plastic materials are manufactured into two basic forms, unexpanded and expanded.

- Unexpanded plastics are a solid high-density product
- Expanded plastics are generally a low-density product and are commonly called "foam plastics"

Unexpanded Plastic (UP)

Treat stored material that meet the following criteria as unexpanded plastics:

a. Total weight or volume of unexpanded plastic is more than 5% for single pallet load.
b. Total volume of expanded plastic (foam plastic) is from 5% to 40% for single pallet load.
c. Total volume of expanded plastic is greater than 5% and up to 10% when exposed or located on the outer portion of the material (i.e protects or envelops the material)

Class 4/Cartoned Unexpanded Plastic (CUP)

If the material considered unexpanded plastic and is stored in corrugated cardboard cartons, treat the commodity as cartooned unexpanded plastic (CUP)/Class 4.

Uncartoned Unexpanded Plastic (UUP)

If the material considered unexpanded plastic and is not stored in corrugated cardboard cartons, treat the commodity as uncartooned unexpanded plastic (UUP).

Expanded Plastic (EP)

Treat stored material that meet the following criteria as expanded plastics:

a. Total volume of expanded plastic (foam plastic) is greater than 40%.
b. Total volume of expanded plastic is greater than 10% when exposed or located on the outer portion of the material (i.e protects or envelops the material)
c. Empty plastic containers that hold more than 1 litre and are not nested.

Cartoned expanded Plastic (CEP)

If the material considered expanded plastic and is stored in corrugated cardboard cartons, treat the commodity as cartooned expanded plastic (CEP).

Uncartoned expanded Plastic (UEP)

If the material considered expanded plastic and is not stored in corrugated cardboard cartons, treat the commodity as uncartooned expanded plastic (UEP).

Examples of Plastics

This chart shows examples of both unexpanded and expanded plastics.

Unexpanded Plastics	Expanded Plastics
Polycarbonates and polyester products	Polystyrene foam plates, cups, etc
Polystyrene finished toy products	Polystyrene foam packaging material,
Polyethylene terephthalate (PET) plastic (other than cups and bottles)	Polyethylene and polypropylene foam sheeting packaging material
PVC finished products with plasticizer greater than 20%	Polyethylene foam pipe insulation
Santoprene (synthetic rubber)	Sealants and electrical insulation (paraffin wax based)

Heat Release Rate

The heat release rate (Btu/min or kW) can be three to five times greater for plastic materials than for a similar arrangement of ordinary combustibles.

Generally the heat release rate for expanded plastics is greater than for unexpanded plastics mainly due to the relatively low density and resulting high burning rate.

9. NOTES