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**Term Paper**

**High-Piled Stock Fire Safety**

**1. Introduction**

*“High-piled storage facilities provide a complex variety of fire problems that often result in total building and contents losses. While built-in fire protection features are intended to mitigate the consequences of an unwanted fire, these features must be designed to match the hazard and maintained over time as commodities and storage methods change. New technology is creating a rapid evolution in the materials handling and storage industry, so fire professionals must stay informed and up-to-date to address the ever-changing risk”* (Hurteau, M. D., Koch, G. W., & Hungate, B. A. (2008)*.*

This modern storage approach, however, is not without inherent fire risks. High-piled and rack storage concentrates fire loads per unit of floor area and trades the problem of horizontal fire spread for vertical. Fires in rack storage configurations can radiate across aisles or travel through obstructed flue spaces and appear in unexpected places. High-piled materials can lose the structural integrity of the pile, fall and spread fire or injure fire fighters. If not properly controlled with shutdown features, automated systems – such as robotics or carousels – can carry burning products far from where the fire originated. o address these common yet complex fire challenges, the International Fire Code (IFC)™ devotes an entire chapter to fire prevention and protection strategies. Coupled with National Fire Protection Association (NFPA) fire detection and sprinkler standards, IFC Chapter 32 provides a comprehensive fire protection strategy for high-piled risk reduction and control (Young, 1970).

**1.1 Quantifying the Hazard**

The foundation for protecting high-piled storage arrays begins with a clear understanding of the product(s) that will be stored. The items must be identified as “commodities” that include three essential elements: the product being stored, its packaging (if any) and the materials handling component on which it is placed (such as a pallet, rack or its own container). Each commodity’s relative combustibility – based on its measured or anticipated latent heat and heat release rate – must be classified to establish the appropriate protection level. This alone can be a daunting task given the nature of ever-changing product components, shipping and packaging practices and how commodities may be aggregated into a single load (Young, 1970).

**2. Review of recent high-piled stock fires**

Modern building and safety regulations should actually prevent the worst from such accidents. The right technology helps in an emergency to keep the fire under control. Here are a few examples of what engineers and chemists have worked out.

**1) Report and delete fire**

Fire detectors warn of fire at an early stage. One example is optical smoke detectors: they trigger an alarm when the infrared light beam inside is deflected by smoke particles and strikes a photosensitive sensor. High-rise buildings usually have fire alarm systems that automatically send a message to the fire department in the event of an alarm and trigger an internal alarm. However, audible warnings throughout the building are often avoided, as they can lead to abuse or panic. Often only a silent alarm is triggered for the staff, for example in hospitals.

In order to extinguish the fire, risers help in high-rise buildings. These are fixed metal pipes, over which the fire department can feed extinguishing water for the upper floors. Sprinkler systems automatically spray water in a fire. At the sprinkler heads are small glass ampoules filled with a special liquid. At a certain temperature, it expands, causing the ampoule to burst, releasing a jet of water.

**2) Prevent spreading of the flames**

The problem with many houses: They are covered with thermal insulation, usually made of polystyrene (Styrofoam) panels - and they can catch fire.

Thermal insulation on an exterior wall (picture-alliance / chromorange / H. Richter)

Unlike Styrofoam, mineral wool (the yellow layer, second from the right) does not burn naturally. In order to prevent the entire façade from being set on fire, fire bars - also known as fire protection strips - are regularly inserted between non-combustible material. They usually consist of mineral wool: it has a melting point of over 1000 degrees Celsius and prevents the flames from spreading to other floors (Hurteau, M. D., Koch, G. W., & Hungate, B. A. (2008).

**3) Plastic that defies the flames**

Plastics burn naturally by nature, especially bulk plastics such as polypropylene. If they decompose in a fire, highly inflammatory substances are also released, aggravating the situation. Caution is especially important in cable insulation: If they are made of highly flammable plastic, a fire could spread over them throughout the house. One solution is to use special plastics that are flame retardant due to their composition. The best example is polyvinyl chloride (PVC), which is made up of many cable insulation. It contains chlorine and quenches a fire almost by itself, because released chlorine stifles the flame.

**3. Types/arrangements of high-piled stock (rack, solid pile, etc.)**

The protection of warehouses against fires is a challenge because they are buildings with a high heating value. In addition to the goods, they contain other elements that promote the spread of flames such as plastics, cardboard or wood. To minimize this risk, warehouses must be equipped with fire prevention, detection and extinguishing systems (Hurteau, M. D., Koch, G. W., & Hungate, B. A. (2008).

The high-piled stock is a key part of the company's supply chain. This is why it is essential to ensure that it is maintained in an optimal state, eliminating risks for people, minimizing damage to goods and avoiding service interruptions. Interruptions of service or the total or partial destruction of a warehouse can result in huge losses, both material and economic, as well as a deterioration of the image of the company.

To minimize these consequences, it is common to sectorize large warehouses. The different areas are separated by walls or fire doors that limit the spread of flames. Preventing, controlling or extinguishing a fire in a building with a calorific value as high as that of a warehouse is a technical constraint that requires a thorough study by an expert.

**3.1 Bearing capacity against fire**

It is the ability of a building element to withstand the exposure to fire for a certain period of time without losing its structural stability. There are programs that can calculate how long the metal structure can withstand fire before it collapses. This time depends on many factors, including:

* The calorific value of the structure.
* The type of fire.
* The existing structure.
* The coating of this structure.
* The location of the installation (if there is humidity, airflow, etc.).

The bearing capacity of a metal structure against fire can be increased by means of passive protection systems (materials and techniques designed to prevent the appearance of fire and to prevent or delay its spread) and / or active protection (by installing equipment and systems to detect and prevent fires).

The fire protection measures that may be applicable in a high-piled stock depend on:

* The standards relating to the subject.
* The size of the warehouse.
* The calorific value of the goods.
* The location of the warehouse compared to other buildings.
* The requirements of insurance companies.
* The interest of the company to protect the stored products.
* Passive protection of metal structures
* Shelves in a warehouse are not required to meet any load bearing capacity requirements.

**4. Review of the commodity classifications**

In the case of steel used in the construction of rack components, the European standard EN 13501 classifies this material as A1 (non-combustible). On the other hand, the most common paints - such as those used by Mecalux - are classified as Bs3d0, according to EN 13501, that is, they are combustible but not flammable. The paints have a thickness less than 100 μ, in case of fire they burn without causing flames. They do not spread fire. However, they do not give the element they cover a bearing capacity against fire. To do this, it would be necessary to use in tumescent paints.

**5. Types of Fire protection system used**

**Fire protection of an object should be achieved using one of the following methods or a combination of them:**

* *“the use of fire extinguishing agents and relevant types of fire fighting equipment;*
* *the use of automatic fire alarm and fire extinguishing installations;*
* *the use of basic building structures and materials, including structures used for claddings, with rated fire risk indicators;*
* *the use of impregnation of the structures of objects with fire retardants and the application of flame retardant paints (compositions) on their surface;*
* *devices that limit the spread of fire;*
* *organization with the help of technical means, including automatic, timely notification and evacuation of people;*
* *the use of means of collective and individual protection of people from fire hazards;*
* *the use of smoke protection”*.

Each object must have such a space-planning and technical execution that the evacuation of people from it was completed before the onset of the maximum permissible values ​​of the dangerous factors of fire.

**5.1 To ensure the evacuation is necessary:**

* establish the number, size and appropriate design of escape routes and exits;
* to ensure the possibility of unimpeded movement of people along the evacuation routes;
* Organize, if necessary, the management of the movement of people through the evacuation routes (light indicators, sound and speech alerts, etc.).

At each facility, timely notification of people and alarm about a fire in its initial stage should be provided by technical or organizational means. The list and justification of the adequacy for the target efficiency of the means of warning and signaling at the facilities is agreed upon in the prescribed manner (Sorensen, C. D., Finkral, A. J., Kolb, T. E., & Huang, C. H. (2011).

**6. A review of appropriate NFPA standards and codes**

The NFPA Standards Council, appointed by the NFPA Board of Directors, is comprised of 13 members. The responsibilities of the Council include overseeing NFPA standards development activities, ensuring compliance with the NFPA Regulations and Rules, appointing members to NFPA Technical and Correlating Committees, and serving as the appeals body over matters related to standards development. The Council conducts meetings three times annually, as well as serving as Presiding Officers for the yearly NFPA Technical Meeting. In the design of active fire protection systems, there are some rules that are usually taken as a reference:

**6.1 Codes and standards**

The association's codes and standards include:

*“NFPA 30, Flammable and Combustible Liquids Code*

*NFPA 70, National Electrical Code*

*NFPA 70B, Recommended Practice for Electrical Equipment Maintenance*

*NFPA 70E, Standard for Electrical Safety in the Workplace*

*NFPA 72, National Fire Alarm and Signaling Code*

*NFPA 77, Recommended Practice on Static Electricity*

*NFPA 101, Life Safety Code*

*NFPA 704, Standard System for the Identification of the Hazards of Materials for Emergency Response*

*NFPA 921, Guide for Fire and Explosion Investigations*

*NFPA 1001, Standard for Fire Fighter Professional Qualifications*

*NFPA 1123, Code for Fireworks Display*

*NFPA 1600, Standard on Disaster/Emergency Management and Business Continuity/Continuity of Operations Programs*

*NFPA 1670, Standard on Operations and Training for Technical Search and Rescue Incidents*

*NFPA 1901, Standard for Automotive Fire Apparatus”*

**Conclusion**

While automatic fire sprinkler protection is undeniably the best protection for stored goods, the IFC recognizes not all high-piled arrays create the same risk level. Other than ordinary housekeeping requirements, the IFC does not even regulate high-piled storage areas less than 500 sq. ft. ( m2).

For small storage areas, fire protection in the form of early detection coupled with methods to control smoke may provide a reasonable level of risk management to enable the local fire services to enter the storage area safely and suppress a fire.

**References**

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