

## **Storage Occupancies – Are Your Sprinklers Up To The Task?**

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### **Introduction**

Almost every business stores something! You don't need to be a big manufacturing or warehousing facility to have storage concerns. Even offices buildings have storage rooms which may overtax the existing sprinkler installation. Are your sprinklers up to the task?

Storage occupancies have been involved in some very large loss fires over the years. Many of these large loss fire occurrences were aggravated by storage conditions, which were not provided adequate sprinkler protection. In some cases, commodities were introduced which exceeded the capability of the existing sprinkler system. In other cases, the storage methods or arrangements were changed, and the sprinklers were not changed to meet the new, higher hazard. Many times a building which is provided sprinkler protection is leased or purchased, and the new storage hazard is greater than the sprinkler system was originally designed to protect.

Storage occupancies range from being considered low hazard to high hazard. Providing adequate sprinkler protection requires a comprehensive analysis which takes into account:

- Storage configuration
- Storage commodity classification
- Building and Storage height
- Aisle width
- Ceiling slope
- Building height
- Ceiling slope
- Type of sprinkler system to be used

The most common methods of storing goods include racks and piles, with the majority of facilities using racks less than 25 feet in height. Many buildings have adequate clear space to accommodate these racking systems. The racking is readily available, can be set up quickly, is less expensive than systems greater than 25 ft., and use generally available lift equipment.

NFPA 13, "Standard for the Installation of Sprinkler Systems©" is one of the most widely referenced documents in the evaluation and design of storage protection. Most fire departments, municipalities, sprinkler contractors, and insurance companies recognize NFPA 13 as the basis of protection criteria. The purpose of NFPA 13 is to provide a reasonable degree of protection for

life and property from fire. NFPA 13 does not intend to prevent the use of alternative protection methods, nor does it intend to restrict the use of new technologies, so long as the degree of protection is not lowered below what is provided in NFPA 13. This topic will use NFPA 13 as the basis for the sprinkler design and storage arrangement.

## What is storage?

Storage is the holding of materials. They may be raw materials, work in process, or finished goods. The storage may be in warehouses, or in production areas. The storage may be the main occupancy, or it may be incidental to the main occupancy (miscellaneous storage).

## Storage configuration

Storage is generally grouped into piled storage and rack storage. Piled storage is the piling of goods, one on top of the other. Rack storage uses a system to racking so that materials may be removed in a predetermined fashion, and sometimes random fashion. Racking introduces the air space around the unit load, and enhances fire growth in the storage arrangement.

## Storage commodity classification

NFPA 13 refers to commodity as: *“3.9.1.4 Commodity. The combination of products, packing material, and container that determines commodity classification.”*

NFPA 13 uses commodity classes as a basis of determining adequate protection. There are four basic commodity classes for ordinary combustibles.

In general, the commodities are:

- Class I: Commodities that are noncombustible products on wood pallets
- Class II: Commodities that are noncombustible in slatted wood crates, or multiple layered corrugated cartons.
- Class III: Commodities that are fashioned from wood, paper, or natural fibers. Class III commodity may also be Class C plastics, or have less than 5% (by weight or volume) of Group A or Group B plastics.
- Class IV: Commodities that are Group B plastics; consist of free flowing Group A plastic materials; or contains an appreciable amount of Group A plastics.

Plastics are grouped into three groups, classified as Group A, B, or C. Plastics are categorized based on the specific plastic materials, and they are listed in NFPA 13: 5.6.4.1; 5.6.4.2; and 5.6.4.3. There are also special commodities, such as rolled paper, flammable liquids, and tires.

## Building and storage height

Storage height is measured from the floor to the top of the storage. The sprinkler system design is based on the storage height and clearance to ceiling. In some cases the protection criteria requires a greater height criteria be used than is normally stored. This is seen in buildings greater than 30 ft. in height where the distance between the ceiling height and top of storage exceeds 20 ft. The protection criteria is then based on the storage height that would result in a 20 ft. distance between the ceiling height and top of storage.

The building is measured from the floor to the underside of the roof deck or ceiling.

Early suppression fast-response (ESFR) sprinklers are to be used only in buildings equal to, or less than, the height of the building for which they have been listed.

## Aisle width

Aisles are very important in storage configurations. Aisles help slow the spread of fire from one group of materials to an adjacent group. Aisles help the sprinkler system by creating a fire break between storage racks or piles, and allowing an open area for the sprinklers to fill with water spray. NFPA takes the aisle spacing into account when determining design criteria.

## Ceiling slope

Sprinkler system design applies to buildings which have a ceiling slope not exceeding 2 in 12, or 16.67% slope. Pitches greater than this require special attention.

## Types of rack storage systems

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The three main types of racks used in industry today are addressed in NFPA 13 as single row, double row, and multiple row racks. NFPA 13 defines each as:

**3.9.3.7.5 Single-Row Racks** - Racks that have no longitudinal flue space and that have a depth up to 6 ft (1.8 m) with aisles having a width of at least 3.5 ft (1.1 m) between loads on racks.

**3.9.3.7.1 Double-Row Racks** - Racks less than or equal to 12 ft (3.7 m) in depth or single-row racks placed back to back having an aggregate depth up to 12 ft (3.7 m), with aisles having an aisle width of at least 3.5 ft (1.1 m) between loads on racks.

**3.9.3.7.3 Multiple-Row Racks** - Racks greater than 12 ft (3.7 m) in depth or single- or double-row racks separated by aisles less than 3.5 ft (1.1 m) wide having an overall width greater than 12 ft (3.7 m).

## **Type of sprinkler systems to be used**

Sprinkler systems should be wet pipe sprinklers. In areas where wet pipe sprinklers cannot be used due to freezing or special conditions, dry pipe or pre-action sprinkler systems may be used. The area of operation is increased by 30% to compensate for the additional time the water takes to arrive at the sprinkler heads.

## **Types of sprinklers**

There are several types of sprinkler heads in use today. Some have specific design and performance characteristics. Not all are suited for storage occupancies. Some of the most common in storage occupancies include the standard upright and pendant spray sprinkler; the Early Suppression Fast-Response Sprinkler (ESFR); the Large Drop Sprinkler; and the Specific Application Control Mode Sprinkler

The standard upright and pendant spray sprinklers are the workhorse of the sprinkler industry. They may be used in all occupancy hazard classifications and building construction types.

ESFR sprinklers are becoming a favorite in warehouses because, in many applications, the need for in-rack sprinklers is eliminated. They may only be used in wet pipe systems, in buildings with flat or low slope ceilings, and where there are not obstructions from building members.

Large drop sprinklers are a type of specific application control mode sprinkler used in storage occupancies. It is capable of producing large water droplets, and is listed for its ability to control specific high-challenge fire hazards. Large drop sprinklers are permitted to be used in wet, dry, or pre-action systems.

The Specific Application Control Mode Sprinkler is designed for a specific task. Each head must follow the listing criteria specified for it. The manufacturer of Specific Application Control Mode Sprinklers, or other qualified person, should be consulted before installing these heads to ensure they are being installed in accordance with their listing.

Each sprinkler head is designed to operate at a given temperature. Each sprinkler must be color code marked with its temperature rating. The marking is usually a color on the frame arms, deflector, coating material, or liquid bulb colored in accordance with NFPA 13. The temperature rating of the sprinkler is crucial in the protection criteria.

## **Sprinkler densities and area of operation**

NFPA 13 uses the density/area method of design criteria. Each sprinkler in the system protecting the storage must flow at least the minimum required density. The area of operation of the system must cover the specified most hydraulically remote area.

For instance, if a storage area needs a ceiling density of 0.20 gpm/sq. ft. over the most hydraulically remote 2,500 sq. ft. of floor area, and the head spacing is 10 ft. between heads and 10 ft. between sprinkler lines, then, we can determine the minimum needed flow from the sprinklers. Each sprinkler head covers 100 sq. ft. of floor area. Multiplying the area times the density needed, we need not less than 20 gpm per head. We also determine that at least 25 heads will be needed to satisfy the requirements of the hydraulically remote area.

Some sprinkler heads do not use the density/area method. ESFR sprinkler systems use the minimum operating pressure for each sprinkler head. Their adequacy is based on the storage arrangement, commodity, maximum storage height, and maximum ceiling height. Tables in NFPA 13 indicate the minimum needed head pressure based on the sprinkler head nominal K-factor. The table will also indicate if in-rack sprinklers are required, the hose demand, and the duration of the water supply.

It should be noted that some sprinkler systems are “Control Mode” systems. This means that they are designed to contain the fire until the fire department completes final extinguishment and overhaul. Other systems, such as some ESFR systems are designed to extinguish the fire with minimal fire department intervention.

## **In-Rack sprinkler systems**

In-rack sprinklers (IRAS) are sprinklers installed at various levels of the rack storage. They may be located in the flue spaces, or at the face of the rack storage. NFPA 13 provides specific placement criteria for IRAS in various areas of the standard. Horizontal and vertical spacing is defined, as well as staggering of heads when multiple levels of IRAS are installed. Generally, whenever solid shelves are used in racks, IRAS is required below each tier of the solid shelves. This is because the solid shelf obstructs the sprinkler discharge flow pattern, and prevents the water from reaching materials below the solid shelving. As a note, slatted shelves are considered equivalent to solid shelves in most applications. NFPA 13 - 16.2.5.1.2 provides requirements that need to be met in order for slatted shelves not to be considered solid shelves.

## **Alternatives to In-Rack sprinkler systems**

While there are reasons to install IRAS, many warehouse managers prefer not to have IRAS installed in their rack systems. They may be concerned about physical damage to the IRAS piping or heads, causing water damage, and disruption of operations. Alternatives include using lower storage height, wider aisles, alternative racking or storage arrangements, higher sprinkler

density, lesser clear space between the top of storage and the ceiling, or changing the commodity itself.

The need for IRAS is linked to the ceiling density needed for a specific scenario. The addition of IRAS typically reduces the ceiling density needed. The ceiling density may be increased to a level which does not require IRAS. Lowering the storage height may directly influence the needed density. Lower storage requires less density for a given area of operation in most building not over 30 ft. in height. Above 30 feet in height, clear space may also be a concern.

Changing the method of storage may eliminate the need for IRAS. For instance, changing from multiple row racks to double row racks with 8 ft. aisles may decrease the needed ceiling density. It may be possible that the existing ceiling sprinkler system will meet the needed density of the new storage configuration.

Packaging may also impact the needed sprinkler protection. Packaging a Class III commodity in an expanded plastic cocoon formed wrap may be classified a Group A plastic commodity. Changing the packaging to a cardboard material may reduce the commodity to a Class III commodity, and require lesser ceiling density, making the IRAS unnecessary.

## **Coordination with the local fire department**

Your employees should know what to do in the event of a fire. There should be an in-house plan of what your employees should do. There should be an emergency coordinator on each shift. There should be a plan of evacuation. Key employees should ensure the sprinkler valves are in their fully open position. A fire pump operator should ensure the fire pump(s) are running, and the operator should remain with the pumps to ensure their continued proper operation. Key maintenance personnel should be available to the fire department to shut off electrical power and operate mechanical equipment as they are asked by the fire department.

The local fire department should be familiar with your facility. There should be a pre-plan in place so they know what they should do to fight a fire at your facility. They should have a site plan showing your building and fire system layout. There should be an annual fire drill and review of emergency procedures.

## **The business impact of having inadequate sprinkler protection**

The difference between an adequate and an inadequate sprinkler system in your storage area may be crucial to your business. A fire which overtakes the capability of your sprinkler systems may not prevent a major, or total, loss to your plant. An adequately designed and maintained system should control, or even extinguish a fire in your storage area.

## **Bibliography**

National Fire Protection Association. *NFPA 13 Standard for the Installation of Sprinkler Systems, 2007 On-line Edition*. Quincy, MA: NFPA, 2007