

LUBBOCK FIRE RESCUE, FIRE MARSHAL'S OFFICE

High Piled Combustible Storage

General Requirements per Chapter 32 of the 2021 International Fire Code



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Purpose

This document will provide the user a basic understanding of high pile storage requirements as found within Chapter 32 of the 2021 International Fire Code, as amended. The document will also describe high pile storage plan submission requirements, and discuss some examples and problem areas concerning high pile storage.

Scope

This document applies to all newly constructed facilities engaging in high pile storage activities or existing facilities where the high pile storage practices have been modified in any manner. High pile storage activities include any and all activities in which combustible materials with a commodity classification of I through IV are stored over 12 feet in height. It also includes any and all activities in which combustible materials with a high hazard commodity classification are stored over 6 feet in height. This document also includes facilities that have the ability for storage practices as noted above, but are currently not doing so.

Storage practices of any kind regarding non-combustible materials are not within the scope of this document.

Definitions

AEROSOL A product which is dispensed from a pressurized aerosol container by the use of a propellant.

AREA CAPABLE OF ACCOMMODATING HIGH PILE STORAGE Buildings containing an area capable of accommodating high pile storage, but which is not being utilized as such.

ARRAY The configuration of storage. Characteristics considered in defining an array include the type of packaging, flue spaces, height of storage and compactness of storage.

ARRAY, CLOSED A storage arrangement having a 6-inch or smaller width vertical flue space that restricts air movement through the stored commodity.

BIN BOX A five-sided container with an open side facing an aisle. Bin boxes are self-supporting or are supported by a structure designed so that little or no horizontal or vertical space exists around the boxes.

COMBUSTIBLE, ORDINARY Commodities consisting of wood, paper, natural fibers, etc.

COMMODITIES The combinations of product, packing material and container upon which commodity classifications are based.

CURTAIN BOARDS or DRAFT CURTAINS Structures arranged to limit the spread of smoke and heat along the underside of the ceiling or roof.

EARLY SUPPRESSION FAST RESPONSE SPRINKLERS (ESFR) A sprinkler listed for early suppression fast-response performance.

EXTRA HIGH-RACK COMBUSTIBLE STORAGE Storage on racks of Class I, II, III, or IV commodities which exceed 40-ft in height and storage on racks of high-hazard commodities which exceed 30-ft in height.

FLUE SPACE, LONGITUDINAL The space between rows of storage perpendicular to the direction of loading.

FLUE SPACE, TRANSVERSE The space between rows of storage parallel to the direction of loading.

HIGH PILED COMBUSTIBLE STORAGE Storage of combustible materials in closely packed piles or combustible materials on pallets, in racks, or on shelves where the top of storage is greater than 12 feet in height. When required by the fire code official, high-piled combustible storage also includes certain high-hazard commodities, such as rubber tires, Group A plastics, flammable liquids, idle pallets, rail-road ties and similar commodities, where the top of storage is greater than 6 feet in height.

HIGH PILE STORAGE AREA An area within a building which is designated, intended, proposed or actually used for high pile combustible storage. This definition is intended to include the actual floor space of racks or piles, and associated aisles, when required.

PLASTICS, GROUP A Group A plastics are plastic materials having a heat of combustion that is much higher than that of ordinary combustibles, and a burning rate higher than that of Group B plastics.

PLASTICS, GROUP B Group B plastics are plastic materials having a heat of combustion and a burning rate higher than that of ordinary combustibles, but not as high as those of Group A plastics.

PLASTICS, GROUP C Group C plastics are plastic materials having a heat of combustion and a burning rate similar to those of ordinary combustibles.

PLASTICS, EXPANDED (FOAMED OR CELLULAR) Those plastics, the density of which is reduced by the presence of numerous small cavities (cells), interconnecting or not, dispersed throughout their mass.

PLASTICS, NON EXPANDED Those plastics with high densities, solid, or not otherwise categorized as expanded, such as polyethylene film, polystyrene toys, polyester and polystyrene plastic tote bins, polyethylene 55-gallon drums or smaller containers, etc.

SOLID SHELVING Fixed-in-place solid, slatted or other types of shelves, located within the racks, and which obstructs sprinkler discharge down into the racks. The area of a solid shelf is defined by perimeter aisle or flue space on all four sides. Solid shelves having an area equal or less than 20 square feet shall be defined as open racks. Shelves of wire mesh, slates or other materials more than 50 percent open, and where the flue spaces are maintained, shall be defined as open racks.

STORAGE, BIN BOX Storage in five-sided wood, metal or cardboard boxes with open face on the aisles. Boxes are self-supporting or supported by a structure so designed that little or no horizontal or vertical space exists around boxes.

Permitting, Plans, and Inspections

PERMITS

A construction and operational (annual) permit is required for all high piled combustible storage locations over 500 square feet in size.

PLANS. High pile storage plans are required for all new high pile storage buildings/facilities, or high pile storage arrangements within existing buildings, with one or more of the following scenarios:

- 2501 square feet or greater of Class I-IV commodity storage.
- 501 square feet or greater of High Hazard commodity storage.

It is important to note that all storage areas within the building contribute to this square footage for the purposes of submitted plans. This is regardless of whether the storage areas are adequately separated, which is discussed later in this document. In other words, the total storage of all storage areas, regardless of separation, is added together and if they meet one or more of the above criteria, plans must be submitted for review.

For example, a building has four high pile storage areas with each storage area totaling 700 square feet of Class IV commodities. The cumulative square footage is 2800 square feet of Class IV commodities. Therefore high pile storage plans are required to be submitted. The submission requirements for these plans are discussed later in this document.

Plan submittal requirements. Required plans must be provided with the following information:

- Lubbock Fire Marshal's Office Plan Review # on the drawings
- Project name and address shown on plans
- Appropriate storage questionnaire attached to plans
- Floor plan of the building showing locations and dimensions of all high-piled storage areas
- Usable storage height for each storage area
- Indications as to rack storage areas and/or pile storage areas
- Location and classification of commodities for all storage areas
- Maximum pile volume for each storage array
- Dimension and location of transverse and longitudinal flue spaces
- Aisle dimensions between each storage array
- Usable storage height for each storage area
- Location of required fire department access doors
- Number of tiers within each rack
- Location of commodities which are banded or encapsulated
- Type of fire suppression and detection equipment
- Location of valves controlling the water supply of ceiling and in-rack sprinklers

- Commodity clearance between top of storage and the sprinkler deflector for each storage arrangement
- Type, location and specifications of smoke removal and curtain board systems
- All vents are provided with labeling in a logical manner
- Additional information regarding required design features, commodities, storage arrangement and fire protection features within the high-piled storage area

If the high pile storage is part of a new building, then one set of high pile storage plans must be submitted along with each construction set that is routed through the Building Department. One additional set is required that will be retained by the Fire Marshal's Office. The remaining sets will be kept with the construction sets. If the storage plans are a result from new storage practices in an existing building, a total of two sets of plans are required. One will be retained and the other will be returned to the owner for the facilities records.

Once the plans have been reviewed and accepted, the contractor/installer may begin installation of the structures in compliance with the accepted plans.

INSPECTIONS.

1. Empty racks/shelves and other furniture be installed per plans
2. Fire extinguishers in place
3. Smoke/heat vents installed and initially tested
4. FD access doors installed and keyed the same
5. Approved Stacking Signage installed at approved heights and intervals
6. Exits clearly identified
7. Occupant load posted
8. Any other items called out in the plan review

Note that the ability to move stock into the building for the high pile inspection is dependent upon all other inspections on the permit card being to the point of allowing a temporary CO status. This must be coordinated with the New Construction Fire Inspectors as well as the High Pile Storage Fire Inspectors.

After this initial inspection has been approved, stock may then be placed in the storage areas. However, this MUST be coordinated with the fire inspectors from Construction Services. If there are any outstanding issues with their inspection, the stock may NOT be placed in the storage areas.

Once the structure passes this inspection, a permit will be issued and the structure may be fully utilized. Any changes in the storage arrangements require plans for the new arrangements to be submitted for review and acceptance.

PERMITS. The operational permit is good for one year from the date of issue. I.e. if the permit is issued on April 12, 2019, then the permit is valid (assuming storage is the same) until April 11, 2020. At that time a new operational permit is required. This new permit drives an annual inspection to ensure the approved storage practices are still approved. If the annual inspection discovers different storage practices or arrangements in use, one of two things must happen:

- 1- The facility reverts to the approved storage methods or
- 2- The facility submits new plans and complies with any new requirements per the current fire code, as amended. Contact the Lubbock Fire Marshal's Office with any questions about this permit.

General Requirements

Commodity Classification. The single most important factor within high pile storage is the accurate determination of the classification of the commodities being stored. All high pile storage requirements, as well as fire sprinkler design parameters, are based on the commodity classifications of the products stored. 2021 IFC Chapter 32, as amended, provides a comprehensive list of commodities and their associated classifications. Refer to this chapter for determining commodity classifications. For any specific questions regarding commodity classification, please contact the Lubbock Fire Marshal's Office.

Limited quantities of Group A plastics. The fire code allows a limited amount of Group A plastics within any commodity classification without increasing the commodity classification. The fire code provides a graph that enables users to determine whether or not the amount of Group A plastics will cause the commodity classification to increase. In order to determine what the final commodity classification is, a minimum of two out of three data points are necessary. Either the percent by volume of expanded plastic or percent by weight of expanded plastic, and percent by weight of unexpanded plastic, are needed. The issue is how to determine these numbers. Figure 1 shows a table from the 2021 IFC, as amended, that is used to determine these numbers.

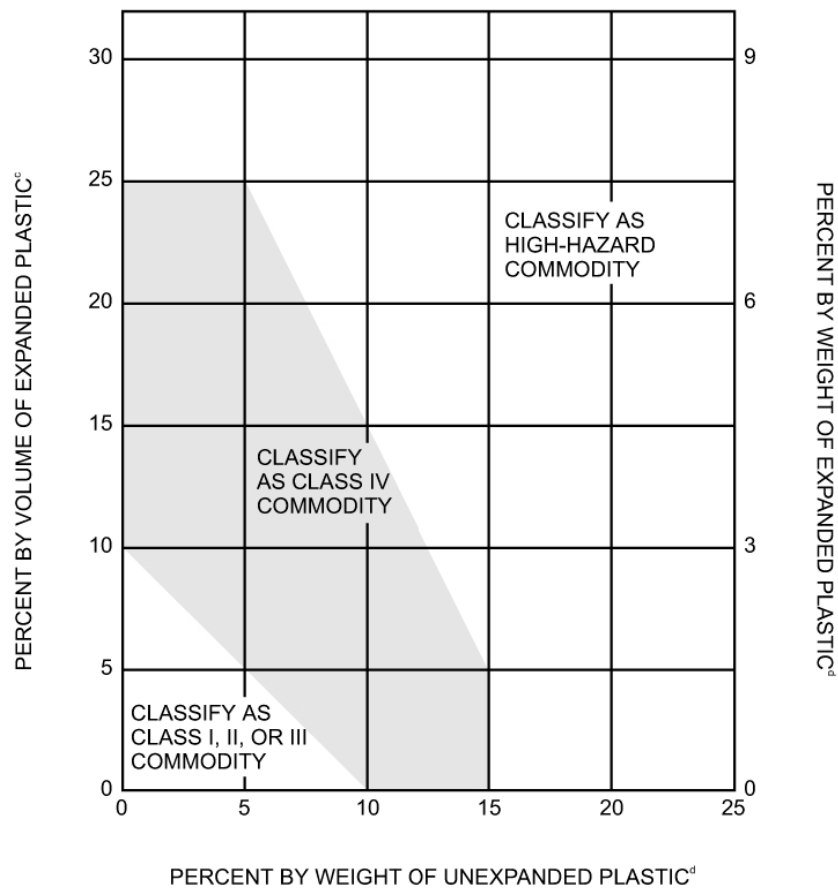


FIGURE 1 - FIGURE 3203.7.4 IN THE 2021 IFC AS AMENDED

The following formulas are used to determine the amounts of plastics within a commodity.

$$\text{Percent by volume} = \frac{\text{Volume of plastic in pallet load}}{\text{Total volume of pallet load, including pallet}}$$

$$\text{Percent by weight} = \frac{\text{Weight of plastic in pallet load}}{\text{Total weight of pallet load, including pallet.}}$$

The formulas are based on an individual pallet or carton load. This means that the entire pallet or carton must be considered in determining the amount of plastics. The following examples help explain this further.

Example #1

Given:

A commodity contains 7 percent by weight of unexpanded Group A plastic and 8 percent by volume of expanded plastic. What is the commodity classification?

Solution:

- Find percent by weight of unexpanded plastic on chart (#1 in Figure 2)
- Find where 7 percent would fall along this axis and draw an imaginary line vertically (#2 in Figure 2)
- Find percent by volume of expanded plastic on the chart (#3 in Figure 2)
- Find where 8 percent would fall along this axis and draw an imaginary line horizontally (#4 in Figure 2)
- Where the lines intersect correlate with a commodity classification

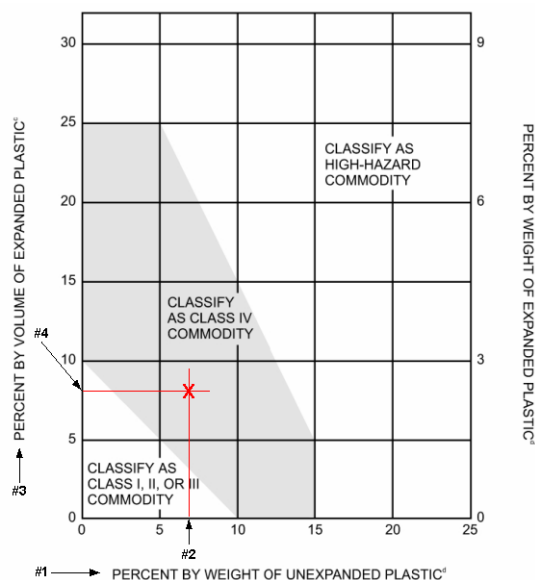


FIGURE 2 - EXAMPLE 1 ILLUSTRATION

Answer: Since the intersection point is within the shaded area identified as Class IV commodity, the commodity shall be classified as such.

Example #2

Given:

A pallet load of 20 scanners has the following dimensions and weights:

- Dimension of pallet load is 4 feet by 4 feet
- Each scanner has 0.5 cubic feet of polystyrene foam packaging
- Entire pallet load weighs 400 pounds
- Each scanner has 2.5 pounds of Group A nonexpanded plastic (rubber rollers, ABS cover, etc.) with remainder of weight load being other than Group A plastics

Solution:

- 0.5 cubic feet of foam packaging per scanner multiplied by 20 scanners = 10 cubic feet
- 4 feet x 4 feet x 4 feet - 64 cubic feet for the entire pallet load
- THEREFORE, 10 cubic feet divided by 64 cubic feet multiplied by 100 percent equals 15.6% by volume of expanded plastic $((10cf / 64cf) \times 100\% = 15.6\%)$
- 2.5 pounds of unexpanded Group A plastic per scanner multiplied by 20 scanners equals 50 pounds of unexpanded Group A plastic. $(2.5lbs \times 20 = 50lbs.)$
- THEREFORE, 50 pounds divided by 400 pounds multiplied by 100 percent equals 12.5% by weight of unexpanded Group A plastics. $((50lbs/400lbs) \times 100\% = 12.5\%)$

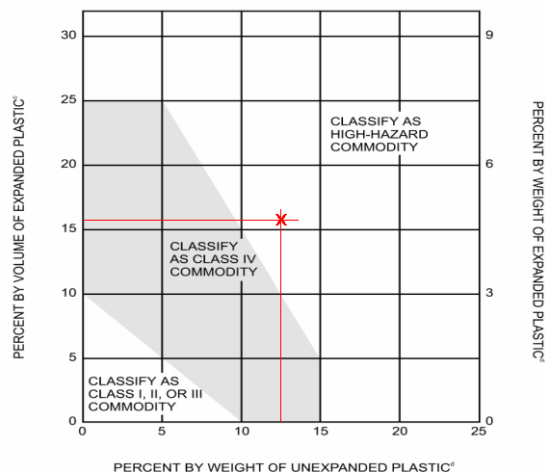


FIGURE 3 - EXAMPLE 2 ILLUSTRATION

FIGURE 3 - EXAMPLE 2 ILLUSTRATION

Answer:

Using the same steps in Example 2, the commodity classification, based on the amount of Group A plastics is High Hazard. See Figure 3.

Separation of high pile storage areas. When required, high pile combustible storage areas must be separated from other portions of the building. Some examples of this include separation between uses, multiple storage areas and storage areas with varying commodity classifications. Each will be discussed.

Separation from other uses. The International Fire Code references the International Building Code for occupancy separation for mixed occupancies. Chapter 3, and more specifically, Table 302.3.2 *Required Separation of Occupancies* of the 2015 IBC, require adequate separation between occupancies within a building. Ensure that any storage areas and their associated occupancy classifications are adequately separated per this Chapter and Table.

Aggregate areas. For the purposes of determining requirements within Chapter 32, when multiple storage areas are proposed, the square footages for all storage areas must be added together. See Figure 4. If storage areas are adequately separated, then each storage area may be considered individually, as shown in Figure 5. Remember, plans are required when high pile combustible storage totals more than 500 square feet. This is regardless if storage areas are separated. Assuming the storage areas are identical occupancy (not commodity) classifications, the IFC requires the separation to consist of a 1-hour rated fire barrier wall and any/all openings to be protected with 1-hour rated assemblies. Provisions within the IBC allow 3/4-rated assemblies within 1-hour rated fire barriers. This common practice is not permitted for the purposes of Chapter 32 of the IFC. Minimum 1-hour rated fire assemblies are required within 1-hour rated fire barriers.

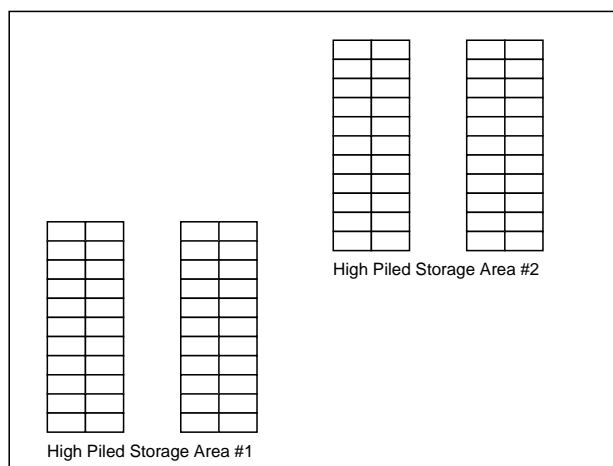


FIGURE 4 - NON-SEPARATED STORAGE AREAS

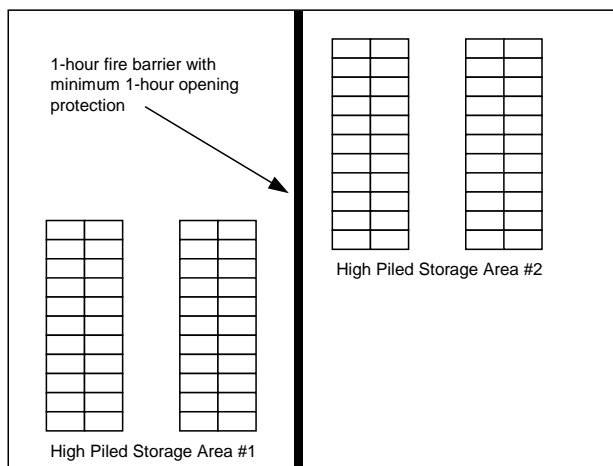


FIGURE 5 - SEPARATED STORAGE AREAS

Multi-class storage areas. When a facility utilizing more than one storage area has at least one of those storage areas consisting of high hazard commodities, with the remainder of the storage areas Class IV or lower commodities, those storage areas must be separated. Otherwise, all storage areas must be designed per High Hazard requirements, regardless of the storage areas' proximity to each other. The required separation is the minimum 1-hour fire barrier and 1-hour fire rated assemblies, as previous discussed. This does not necessarily mean that each storage area must be separated from all of the others; it means that if the storage area storing high hazard commodities is not adequately separated from the others, then all storage areas are processed at the high hazard commodity classification. This will be discussed in more detail later in this document.

General Fire Protection and Life Safety Requirements. Based on the commodity classifications of the products stored and the square footage(s) of the storage areas, certain provisions are required as per Table 3206.2, *General Fire Protection and Life Safety Requirements*. Table 3206.2 is provided below for reference. Note that this table has been amended from its original version. The most noteworthy amendment with this table is the elimination of the differences in Public and Non-public accessible spaces. Essentially, the provisions for a Fire Detection System have been eliminated. The only system required (when required) is a fire sprinkler system. Each requirement within this table will be discussed.

GENERAL FIRE PROTECTION AND LIFE SAFETY REQUIREMENTS

COMMODITY CLASS	SIZE OF HIGH-PILED STORAGE AREA ^a (square feet) (see Sections 3206.2 and 3206.4)	ALL STORAGE AREAS (See Sections 3206, 3207 and 3208) ^b					SOLID-PILED STORAGE, SHELF STORAGE AND PALLETIZED STORAGE (see Section 3207.3)		
		Automatic fire-extinguishing system (see Section 3206.4)	Fire detection system (see Section 3206.5)	Building access (see Section 3206.6)	Smoke and heat removal (see Section 3206.7)	Draft curtains (see Section 3206.7)	Maximum pile dimension ^c (feet)	Maximum permissible storage height ^d (feet)	Maximum pile volume (cubic feet)
I-IV	0-500	Not Required ^a	Not Required	Not Required ^e	Not Required	Not Required	Not Required	Not Required	Not Required
	501-2,500	Not Required ^a	Yes ^f	Not Required ^e	Not Required	Not Required	100	40	100,000
	2,501-12,000	Yes	Not Required	Not Required ^e	Not Required	Not Required	100	40	400,000
	12,001-20,000	Yes	Not Required	Yes	Yes ^j	Not Required	100	40	400,000
	20,001-500,000	Yes	Not Required	Yes	Yes ^j	Not Required	100	40	400,000
	Greater than 500,000 ^g	Yes	Not Required	Yes	Yes ^j	Not Required	100	40	400,000
High hazard	0-500	Not Required ^a	Not Required	Not Required ^e	Not Required	Not Required	50	Not Required	Not Required
	501-2,500	Yes	Not Required	Not Required ^e	Not Required	Not Required	50	30	75,000
	2,501-300,000	Yes	Not Required	Yes	Yes ^j	Not Required	50	30	75,000
	300,001-500,000 ^{g, h}	Yes	Not Required	Yes	Yes ^j	Not Required	50	30	75,000

Automatic fire extinguishing systems. Chapter 32 only states when a fire sprinkler system is required. Chapter 32 does not state which type of fire sprinkler system is required. It is beyond the scope of Chapter 32 and this document to discuss fire sprinkler systems and high pile storage, other than to note in the table above when a fire sprinkler system is required.

Fire detection systems. Another important amendment is the elimination of any requirement for fire detection systems. Previously, fire detection systems were permitted in lieu of fire sprinkler systems and other provisions when specific-sized storage areas were considered non-accessible to the public. As with fire sprinkler systems, it is beyond the scope of Chapter 32 and this document to discuss fire alarm systems, other than what has been previously discussed.

Building access. When required, access doors that lead directly into the high pile storage areas from adjacent fire apparatus access roads, are to be installed. These doors must be keyed for fire department use, which means that all doors must be keyed such that one key may open any of the doors, and that key must be provided in the building's Knox™ lock box. These keys must also be labeled for their use. The access doors shall not be less than 3 feet in width and 6 feet, 8 inches in height. The use of a ladder to access the doors is prohibited, and utilizing roll-up doors as the access doors are not permitted.

Access doors are required for each 100 lineal feet, or fraction thereof, of storage area exterior walls that front fire apparatus access roads. This means that if an office and warehouse with high pile storage fronts a fire apparatus access road, and the total length of the warehouse portion fronting the access road is 250-feet, a total of 3 access doors are required. Again, one door is required for each 100 lineal feet or fraction thereof. There are two 100-foot segments, plus one, fraction of a 100-foot segment; hence, 3 access doors. These access doors may be located at any point along each 100-foot lineal section. This means that the doors could be as close as a few feet apart, to as many as 200-feet apart. As long as at least one door is provided for each 100-ft lineal section of an exterior wall of a

high pile storage area that fronts a fire department access road, the intent of the code is met. See Figure 6 for an illustration of this. If fire apparatus access roads are provided along either side and/or back of this example, additional doors would then be required.

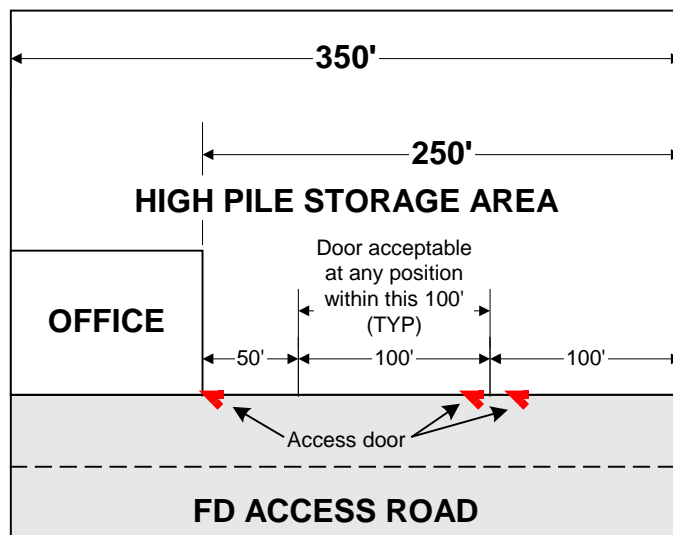


FIGURE 6 - ACCESS DOOR REQUIREMENT AND LOCATION EXAMPLE

Smoke and heat vents. Smoke and heat vents are required as dictated by Table 3206.2. The Lubbock Fire Marshal's Office is well aware of studies performed that suggest smoke/heat vents interfere with the designed operation of fire sprinklers. Despite these studies, smoke/heat vents are still required. However, when vents are provided in buildings that utilize fire sprinklers, the fusible element of the vent must be at least 100° F above the operating temperature of the sprinklers within immediate vicinity of the vent. Therefore, if the temperature rating of the sprinklers is 286° F, the fusible element of the vents must be at least 386° F. This is to help ensure that the sprinklers operate as designed and are minimally affected by vent operation. Additionally, the Lubbock Fire Rescue does not utilize the vents as an automatic fire protection feature of a building. Although the vents will operate automatically, the intent with the vent use is to allow ease in manual venting and to reduce the chance of firefighters having to cut a hole in a roof to vent it. Firefighters would be able to open vents strategically to evacuate smoke and heat. Due to this, all smoke and heat vents must open automatically as well as have approved means of manual opening from the roof. All vents must be labeled, both inside and out, in a logical manner. The labeling scheme must be indicated on the plans.

With that said when a building employs an ESFR, "Early Suppression Fast Response", sprinkler system or a control mode special application sprinklers (CMSA) with a response time index of 50 (m*s)^{1/2} or less that are listed to control a fire in the stored commodities with 12 or fewer sprinklers, the requirement for smoke/heat vents may be eliminated. This provision is found in Footnote "J".

Smoke vent calculation. To determine the number of required smoke/heat vents, the equations 9-3 and 9-4 from Section 910.3.3 of the IFC is utilized.

The required aggregate area of smoke and heat vents shall be calculated as follows:

- For buildings equipped throughout with an automatic sprinkler system in accordance with Section 903.3.1.1:

$$A_{VR} = V/9000 \text{ (Equation 9-3)}$$

where:

A_{VR} = The required aggregate vent area (ft²).

V = Volume (ft³) of the area that requires smoke removal.

- For unsprinklered buildings:

$$A_{VR} = A_{FA} / 50 \text{ (Equation 9-4)}$$

where:

A_{VR} = The required aggregate vent area (ft²).

A_{FA} = The area of the floor in the area that requires smoke removal

The equations provide the aggregate vent area required based on either the volume of the storage area, or the floor area depending on if the building is equipped with an automatic sprinkler system or not. For example, in a nonsprinklered building, the floor area of the storage room is 10,000 square feet. To determine the aggregate floor area, divide this number by 50, which is equal to 200sqft.

Now that the total vent area is known, the number of vents required may be calculated. Note that the number of vents is based on the individual size of the vents being installed. The typical vent size is 4' x 8' (32sf total) and will be used in this example. Therefore, to determine the total number of vents, divide the calculated vent area by 32. This results in 6.25 vents required. When the number of vents calculated includes a fraction (number right of decimal) the number must be rounded up to the next whole number. For this example, the total number of vents required is 7 vents.

Draft curtains. As stated previously, draft curtains are not permitted within sprinklered buildings. Additionally, draft curtain requirements in high pile storage facilities have been amended out of the adopted fire code. Therefore, for the purposes of this document, no further information regarding draft curtains will be provided.

Solid pile storage. There are three typical methods of storage that include solid pile, shelf and rack storage. A significant difference between the solid piles and shelf/rack storage is that the shelves/racks are typically secured to the floor. Solid piles of combustibles are not secured to the floor and the areas they occupy may be expanded, contracted or moved at any time. Because of this, all storage pile areas are required to indicate the boundaries for the piled storage. This may be done with paint, tape or other approved striping on the warehouse floor. There are no requirements as to the color or width of the striping, other than it must be present. However, yellow tape and/or paint has typically been used to delineate these areas.

Hazardous materials storage. The storage of hazardous materials must be in compliance with all applicable fire code and national standards. Refer to applicable codes and national standards for additional information. For specific questions regarding hazardous materials storage, contact the Lubbock Fire Marshal's Office.

PUTTING IT ALL TOGETHER - HIGH PILE STORAGE EXAMPLES

Single storage area, Class I through IV commodities. For a single storage area, there are no differences in requirements between Classes I through IV commodities. Therefore, as an example, if sprinklers are required for a Class II commodity, based on a given amount of storage space, sprinklers will also be required for Class I, III or IV for that same amount of storage space. However, it may be possible to separate the storage by approved methods such that the smaller storage area sizes fall below sizes for requirements. These types of storage areas are the easiest to design. The differences in commodity classifications would play a role in the sprinkler system design, if applicable.

Multiple storage areas, Class I through IV commodities. There may be instances in which a facility wishes to store a specific commodity classification in a specific area. The code allows this practice. Additionally, if the individual storage areas are adequately separated, as previously mentioned, each storage area, not the aggregate of the areas, is required to meet high pile storage requirements. This means that if designed properly, each storage area may not require sprinklers, smoke/heat vents and access provisions. See Figure 7 for an illustration of this.

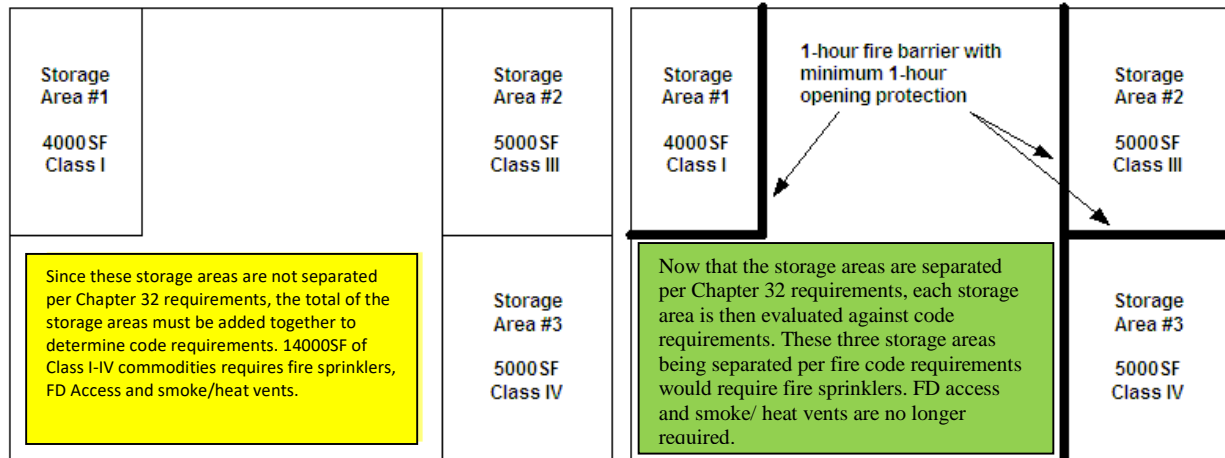


FIGURE 7 - EXAMPLE OF SEPARATED AND NON SEPARATED STORAGE AREAS AND APPLICABLE REQUIREMENTS

Now that the storage areas are separated per Chapter 32 requirements, each storage area is then evaluated against code requirements rather than all areas combined. These three storage areas being separated per fire code requirements would only require fire sprinklers. FD access and smoke/heat vents are no longer required.

Multiple storage areas, Class I through IV and high hazard commodities. High hazard commodities present unique concerns with high pile storage design. This is due to the fact that high hazard commodities burn more intensely than Class I-IV commodities. Therefore are defined as combustibles stored greater than 6 feet (Class I-IV is combustibles over 12 feet), and requirements for fire sprinklers, smoke/heat vents and FD access begin at smaller sizes of storage areas. See Table 3206.2. So the principles of aggregation and separation play a particular role. A facility may have 1,000SF of high hazard commodities with the rest of a 100,000SF being Class IV commodities or less. However, if the high hazard commodities are not separated per code, the entire facility is considered a high hazard commodity.

As an example, a facility currently has one storage area with a total of 17,500SF of mixed commodity storage (12,000SF of Class I-IV and 2,500SF of high hazard) to 19 feet in height. The facility is bound by a fire apparatus access road on three sides. Being a single storage area, the entire area must meet the requirements of the greatest hazard. In this instance it is high hazard commodities. Therefore 17,500SF of high hazard storage requires 11 smoke/heat vents, 4 FD access doors and fire sprinkler system designed for the high hazard commodity. See Figure 8 below.

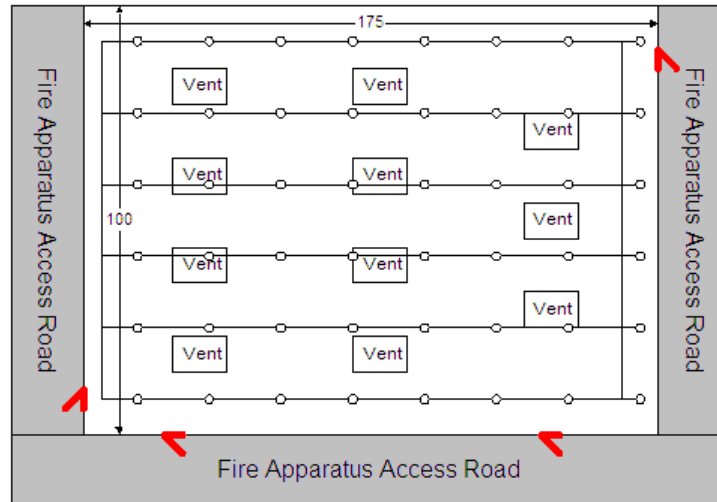


FIGURE 8 - MULTI-COMMODITY NON-SEPARATED STORAGE AND APPLICABLE REQUIREMENTS

The total cost of the sprinkler system, access doors and vents could be significant in the budget for this project. However, if the storage was rearranged such that the high hazard commodities were separated, per fire code requirements, from the remaining commodities, the requirements in Chapter 32 are reduced. The only requirement for high pile storage facilities with 2500SF of high hazard and 12,000SF of Class I-IV commodities that are separated per fire code requirements is a sprinkler system. Therefore, the costs for the vents and access doors are eliminated for the cost of a 1-hour fire barrier and 1-hour opening protection. See Figure 9.

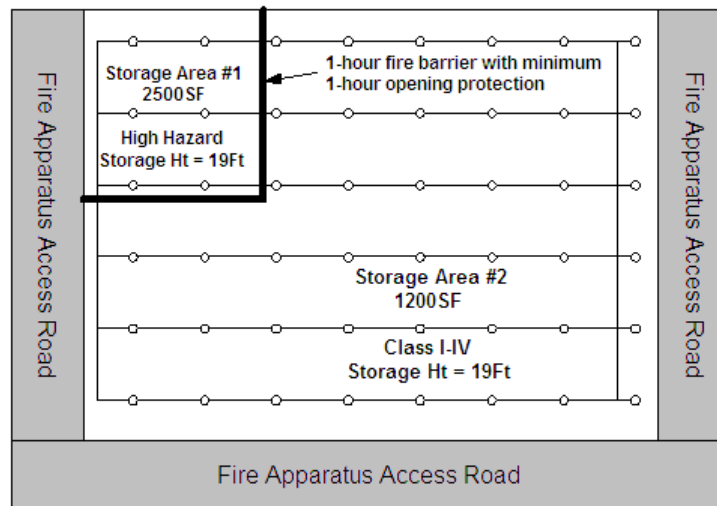


FIGURE 9 - MULTI-COMMODITY SEPARATED STORAGE WITH APPLICABLE REQUIREMENTS

FACILITIES CAPABLE OF HIGH PILE STORAGE BUT NOT PRACTICING HIGH PILE STORAGE

From time to time, a building is designed such that ceiling heights are tall enough to allow storage meeting the definition of high pile combustible storage. However, the facility does not employ such storage practices. These are considered facilities that are capable of, but not practicing, high pile storage. When a facility falls into this category, a high pile storage waiver is required to be signed and placed on file within the Lubbock Fire Marshal's Office. This waiver is a declaration signed by the owner of the building that high pile storage of combustible materials will not be practiced in the building. The declaration also states that if such practices are found, during an inspection or at any other time, the facility must revert back to non high pile practices, or the building or facility must come into full compliance with the current fire code.

Approved signage is required throughout all areas within a building capable of, but not practicing, high pile storage. Spaces such as atriums, with vaulted ceilings (as in churches), auditoriums and other similar spaces are not applicable to this requirement. See the section on *Signage Construction and Design Requirements* for the required signage in

these locations. If there is any uncertainty if signage is required in such a space, contact the Lubbock Fire Marshal's Office for clarification.

SIGNAGE CONSTRUCTION AND DESIGN REQUIREMENTS

This is required for all high pile storage facilities. All signage shall be a minimum of 1 foot by 3 feet and shall be constructed of durable materials such as metal or plastic. Signs constructed of paper, cardboard or similar materials are not acceptable. Each sign shall be provided with "NO STACKING ABOVE THIS LINE" and "BY ORDER OF THE LUBBOCK FIRE MARSHAL'S OFFICE" wording in 2 inch black letters with at least a 1/2 inch stroke on a white background. Additionally, each sign shall be provided with a 3 inch wide red stripe the full width of the sign. Within this red stripe, the maximum height permitted and highest commodity classification (if applicable) shall be stated in 2 inch white letters with at least a 1/2 inch stroke. All graphics shall be printed on the sign, or otherwise permanently affixed to the sign. See Figure 10 for signage specifications.

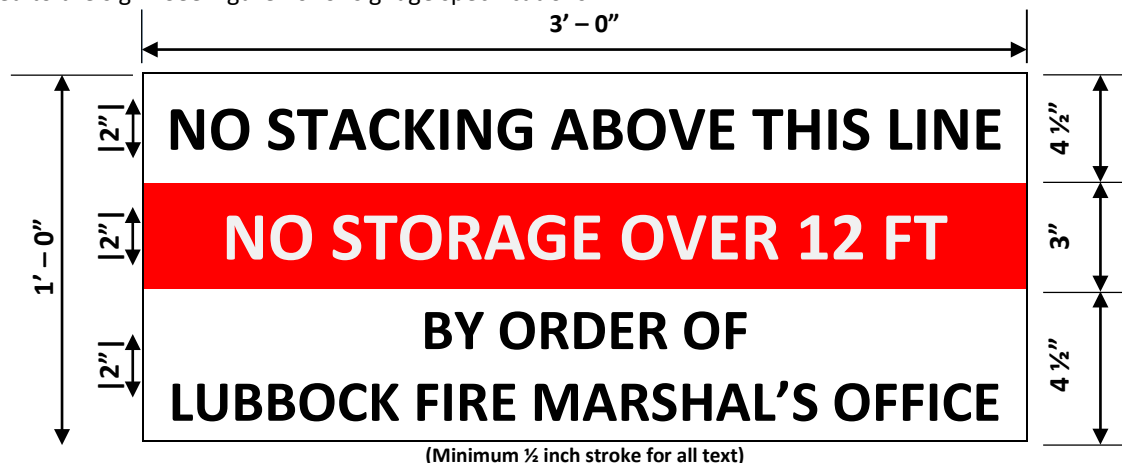


FIGURE 10 - SIGNAGE SPECIFICATIONS

The layout or arrangement of the required signage features is flexible. See Figure 11 for examples of acceptable arrangements.

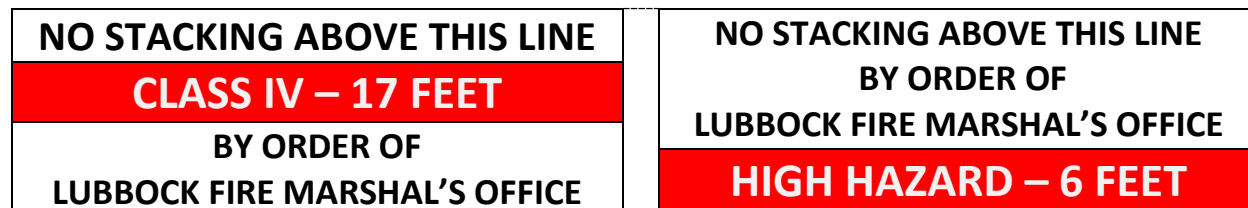


FIGURE 11 - OTHER ACCEPTABLE SIGNAGE ARRANGEMENTS

Facilities capable of, but not utilizing high pile storage. Signage used in areas capable of, but not practicing high piled storage shall be the same dimensions, color scheme and wording with one exception. The red stripe does not contain any wording and is left as a solid red stripe. This allows the signs to be used when the area is used for high pile storage by affixing the proper wording to the red stripe. Signs shall also be constructed of durable materials such as metal or plastic. Signs constructed of paper, cardboard or similar materials are not acceptable. All graphics shall be printed on the sign, or otherwise permanently affixed to the sign. See Figure 12 for an acceptable example.

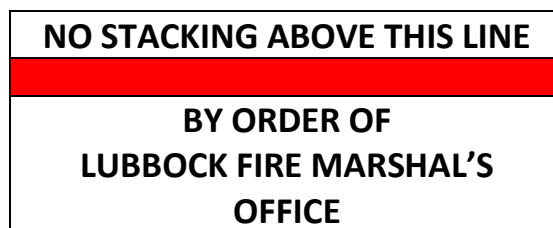


FIGURE 12- EXAMPLE OF SIGNAGE TO BE USED IN AREAS CAPABLE OF HIGH PILE STORAGE

Striping. An acceptable alternative to signage is striping. The striping shall consist of a 3 inch solid red stripe running the entire perimeter of the area. The red stripe shall have 2 inch white wording having at least an 1/2 inch stroke. Figure 13 depicts an illustration of the striping design; however, does not show the acceptable required wording.



FIGURE 4 - STRIPING DESIGN EXAMPLE

For areas with high pile storage, required wording shall state "NO STACKING ABOVE THIS LINE BY ORDER OF LFMO". The greatest commodity classification and maximum storage height permitted shall also be provided. All wording shall be oriented as shown in Figure 14. Wording shall be spaced at 50-foot intervals as measured from end of wording to start of wording as depicted in Figure 15.



FIGURE 5 - ACCEPTABLE ORIENTATION OF REQUIRED WORDING



FIGURE 6 - REQUIRED STRIPE WORDING AND SPACING EXAMPLE

For areas capable of, but not practicing high pile storage, the only acceptable form of stacking limit identification is the approved signage mentioned above. Striping is not permitted.

SIGNAGE AND STRIPING INSTALLATION REQUIREMENTS

All high pile combustible storage areas and those areas capable of, but not practicing high pile storage, are required to install applicable signage at the maximum permitted height of the storage. The signage is designed to provide a visual indicator that storage must not exceed a certain height. If storage exceeds permitted heights, a resulting fire could very easily and quickly overtake a sprinkler system (if present) because along with other variables, the sprinkler system is specifically designed for a given height of storage. Storage exceeding permitted heights in unsprinklered buildings presents a significant hazard for firefighters as the height of the storage affects the penetrability of fire hose streams. Therefore, it is extremely important for the designed storage height permitted within a storage area to remain at that height. Storage heights not in compliance may be the difference between a single pallet fire and a complete building loss.

All signage and striping must be installed to provide maximum visibility. The top of the red stripe, whether on signage or striping alone, shall be installed at the maximum storage height permitted as measured from the floor. See Figure 16.

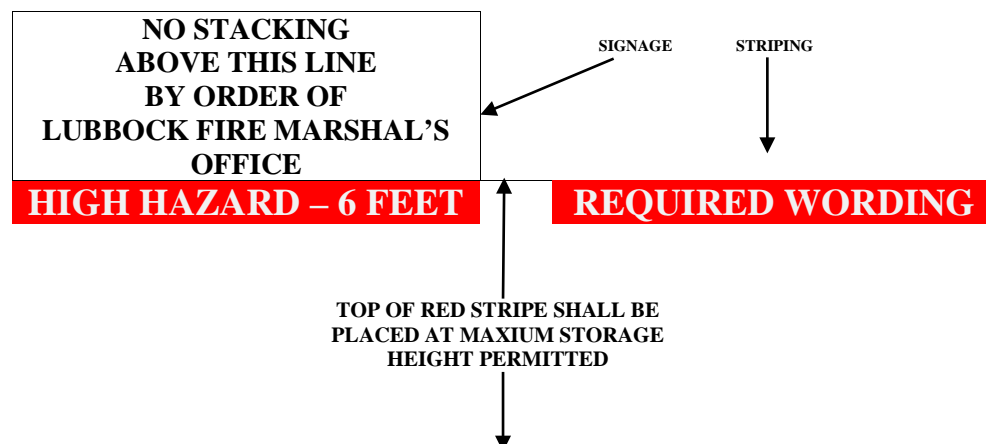


FIGURE 7 - SIGNAGE AND STRIPING VERTICAL INSTALLATION EXAMPLE

Signs shall be placed a maximum of 25 feet from all corners within a storage area, and shall be spaced a maximum of 50 feet between signs along perimeter walls of the storage area. Signage may be adjusted to provide enhanced visibility while not exceeding the maximum distances. For example, depending on the layout of aisles, signage may be adjusted so that the sign is centered on the aisle. See Figures 17-19.

Internal portions of the storage area shall be signed or striped, as well. If columns are available, signs may be mounted to the columns in such a way as to provide maximum visibility. This may include providing signs on more than one side of the column. Striping shall encompass all applicable columns. When columns are not present, the signage may be hung from the roof supports. These signs would be provided at the required spacing.

If the spacing of the columns is greater than 50 feet, signs or striping shall be provided for all applicable internal columns. When column spacing is less than 50 feet, signs or striping shall be provided on all applicable columns not to exceed 50 feet spacing. See Figure 18 for an illustration.

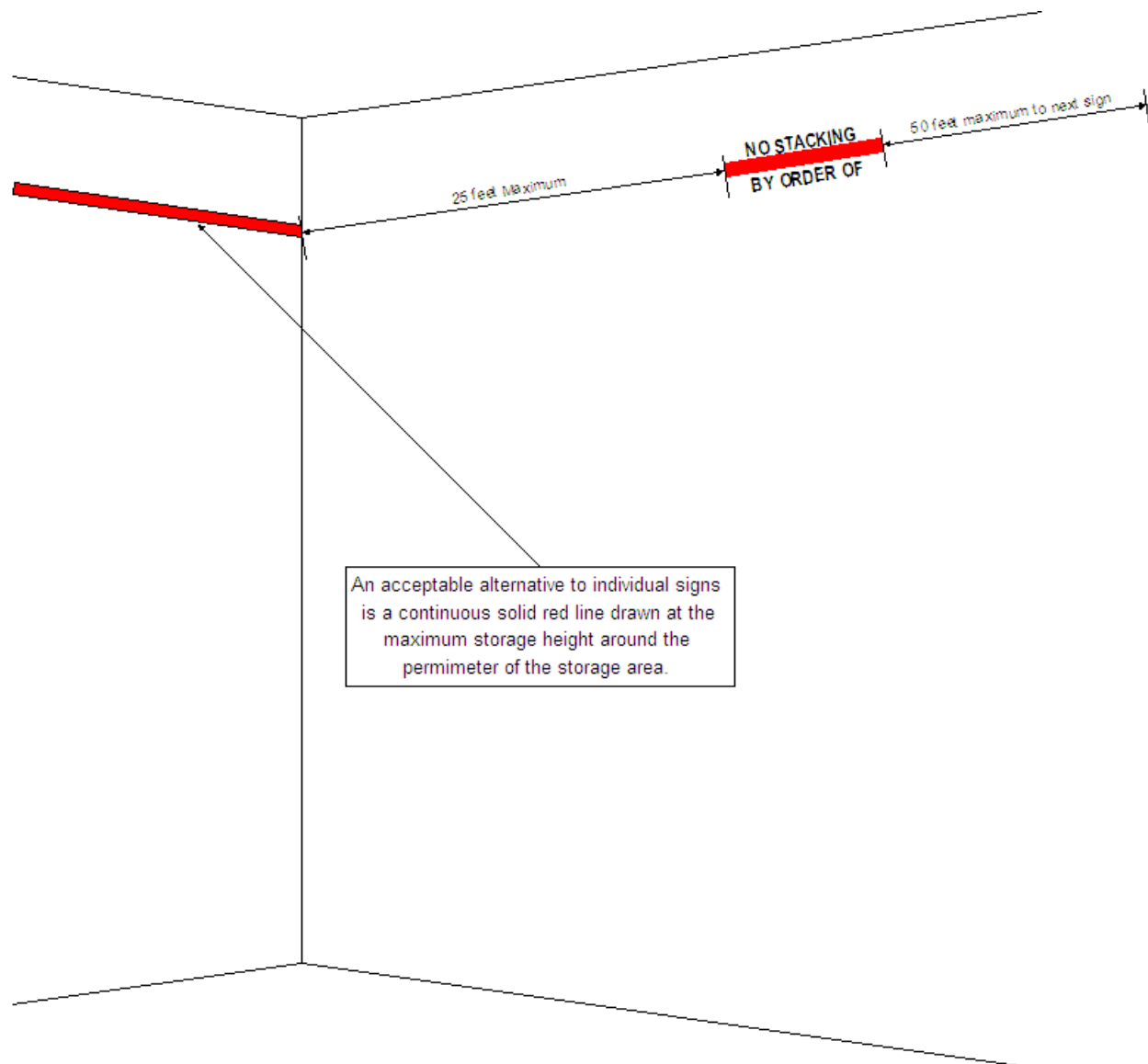


FIGURE 8 - ISOMETRIC CORNER EXAMPLE FOR MARKING INSTALLATION

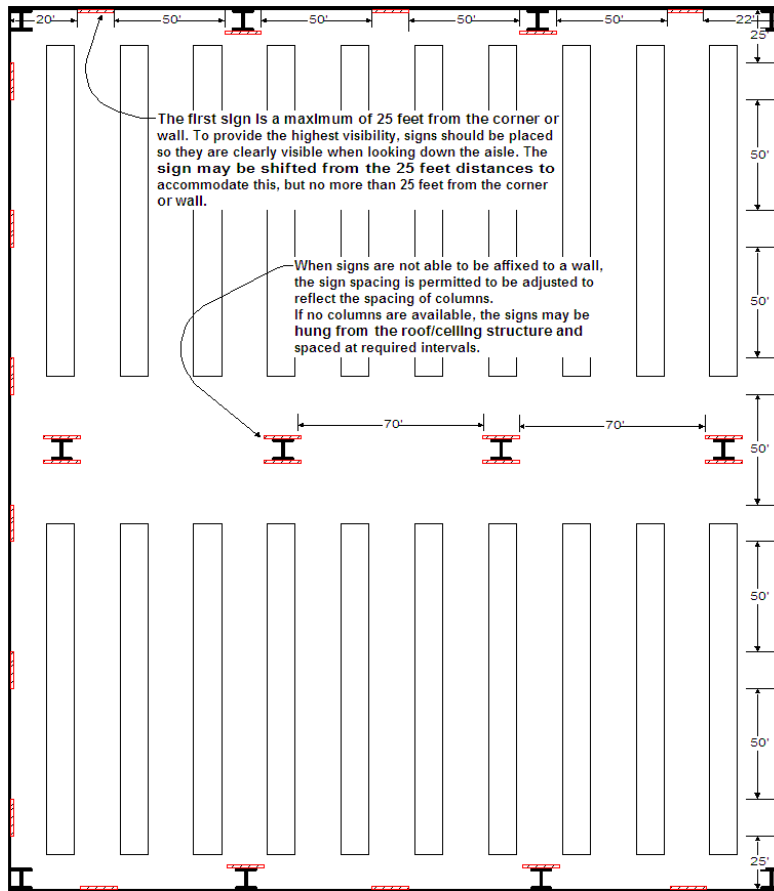


FIGURE 9 - SIGNAGE PLACEMENT AND SPACING EXAMPLE

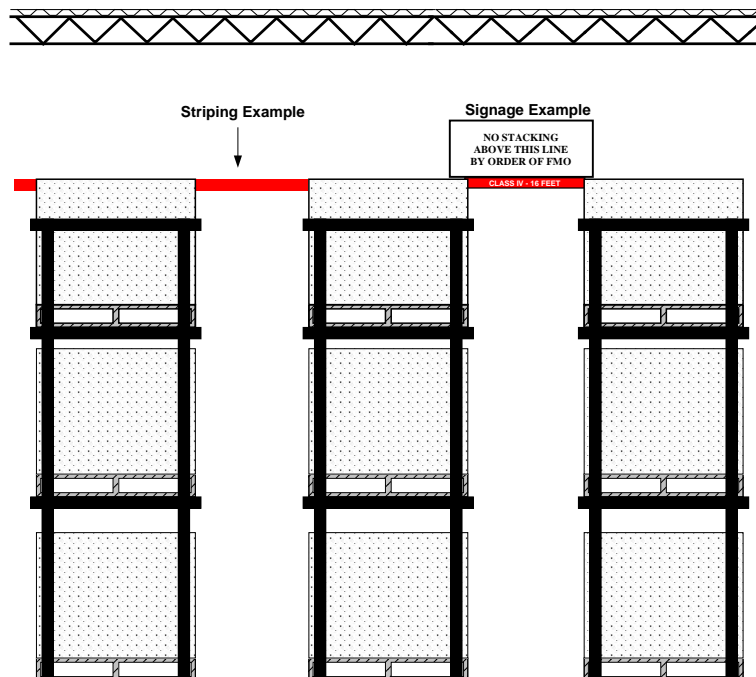


FIGURE 10 - END OF AISLE VIEW OF SIGNAGE AND STRIPING PLACEMENT EXAMPLE

COMPLETING THE STORAGE QUESTIONNAIRES FOR NEW BUILDINGS OR TENANTS

General Storage (Class I-IV Commodities)

Completely and accurately fill out the High Pile Combustible Storage Questionnaire. The questionnaire should be completed and signed by a person qualified to answer these questions correctly. The following is a breakdown of each section of the questionnaire and commentary explaining the information being sought.

Business Name. Please provide the name of the tenant/business which will be occupying the space intended for stocking of high piled combustible materials.

Business Address. The correct and complete address must be provided to insure the correct information is in our database and on the high piled combustible storage permit.

Business Telephone. Provide at least one daytime phone number for the business that can be used as a contact for any questions or concerns. If possible, include a fax number and a secondary number.

Item 1. **Commodity Classifications.** Identifying commodity classifications is the first step in determining applicable fire code requirements. Fire protection measures, such as fire sprinkler designs, are also based on commodity classifications. If a commodity is misclassified and fire sprinkler systems are designed for the incorrect classification, a resulting fire may easily overtax the sprinkler system causing the sprinkler system to be ineffective. Therefore accurately classifying commodities is imperative. It is understood that difficulties may arise in trying to determine appropriate classifications. Document 3 provides a comprehensive listing of various commodities, with their classifications. If difficulties are still being experienced, please contact the Lubbock Fire Marshal's Office.

Item 2. **Description of Storage.** Provide an accurate and detailed description of all current storage practices in the facility. If commodity classifications are known, provide descriptions of where and how each classification is being stored. For example, Class I commodities being stored throughout the facility; Class IV commodities being stored on racks 1-5 to heights of 22 feet. and Class III commodities being stored on racks 5-10 to heights of 15 feet.

Note: If plastics are being stored, identify this in the description, and also complete the Plastics Questionnaire.

Item 3. **Maximum Storage Height.** Provide the maximum height(s), in feet, of the storage within the facility. This measurement is taken from the floor to the **top** of the stored commodity, not to the highest shelf or rack.

Item 4. **Clear Ceiling Height.** This is the measurement, in feet, from the floor of the high piled storage areas to the bottom of the roof deck.

Item 5. **Clear Height.** The measurement, in feet, from the floor of the high piled storage areas to the bottom of the structural supports of the roof deck. This may be the bottom of the roof joists, twin "T's", rafters, etc.

Item 6. **Method of Storage.** Indicate all methods in which commodities are currently being stored. Photographs, specification sheets and other information may be submitted to provide a better understanding of how commodities are being stored.

Item 7. **Rack Storage Information.** Provide as detailed and accurate information as possible.

Type of Racks. Single row racks are those racks in which commodities may be reached from either side of the rack. No flue space is located in the middle of single row racks. Double row racks allow access from a single side of the individual rack, with a flue space in between the racks. See Figure 20. Multiple row racks are similar to double row racks, but incorporate more than two racks. Multiple row racks will be more than two pallets deep.

Height of Racks. Indicate if racks are "x" ft high in one area and "y" ft high in other areas or a constant height throughout. This measurement is from the floor level to the highest possible level or shelf the racks. Rack specification sheets may be submitted, as well.

Depth of Racks. This measurement is from the front of the rack or aisle, to the back of the rack either aisle (for single row racks) or flue space (for double and multiple row racks). If different

width racks are present, indicate all widths of all racks. For double or multiple row racks, indicate the total widths (depths) of each double or multiple rows.

Width of Racks. This is the side-to-side measurement of the racks. Provide the total width of the racks for each row. The width measurement is measured parallel to the aisles.

Aisle Widths Between Racks. Typically the aisle widths will be either 4 or 8 feet wide. However, other aisle widths are definitely possible. Indicate the smallest dimension on the questionnaire, but be sure to show all aisle widths on the drawings. See Figure 21.

Longitudinal and Transverse Flue Spaces. Indicate both of these flue spaces in inches for the current storage practices in the facility. See Figure 20.

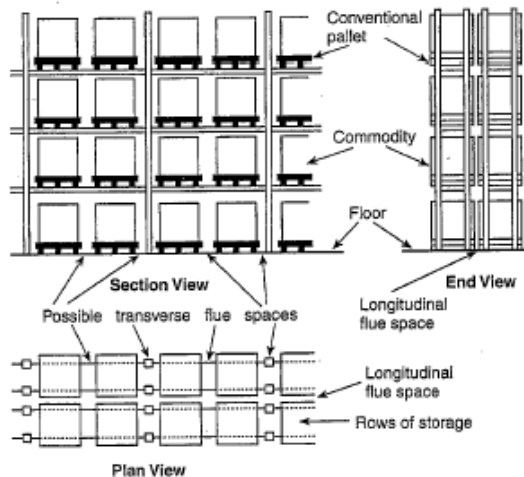


FIGURE 11 - TYPICAL DOUBLE ROW RACK WITH FLUES

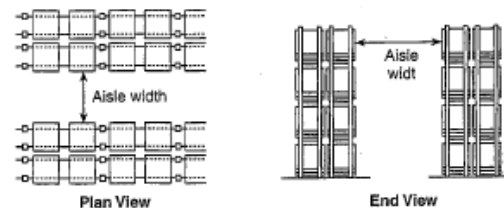


FIGURE 12 - ILLUSTRATION OF AISLE WIDTH

Item 8. **Mechanical Smoke Removal Systems.** "Mechanical" refers to smoke that is forcibly removed out of the facility, or air forcibly pushed into the facility, to pressurize the facility. These systems may include fans either positioned on the roof or towards the tops of exterior walls. Mechanical smoke removal systems are not smoke vents.

Item 9. **Smoke Vents.** Based on the requirements of Chapter 32 in the 2021 IFC, determine if smoke vents are required.

Vent to Ceiling Area Ratio. Once smoke vents are required, the applicable vent to ceiling ratio must be determined. Equations -3 and 9-4 taken from the 2021 IFC Section 910.3.3 provides the available vent areas based on the situation.

Number of Vents Required. Provide the total number of vents that are required based on the vent to ceiling area ratio chosen.

Item 10. **Draft/Curtain Boards.** Indicate if draft or curtain boards are being proposed. Keep in mind that these devices are only permitted in non-sprinklered buildings.

Item 11. **Gross Square Footage of Entire Structure.** Provide the gross square footage of the entire facility. This figure includes all portions of the structure, as well as each individual floor, mezzanines, etc.

Item 12. **Square Footage of High Piled Storage Areas Only.** Provide the square footage for all areas used for the high piled storage of combustibles. If more than one area is present and the areas are separated in some fashion (either by distance or barrier) indicate the sizes for each area. If more than one area is present and not separated in some manner, sum all areas into one area. For those areas that are separated, indicate this with a number in the check box next to the appropriate size for each area. Otherwise, check the appropriate box. The areas used in this measurement are all floor spaces being used by racks and/or piles, plus the required aisles for each area. A general rule of thumb for numerous rows of racks or piles

is to include all aisles between the racks and piles, as well as any applicable required aisles elsewhere throughout the storage.

- Item 13. **Fire Sprinklers Throughout/Partial.** Indicate if the facility will be sprinklered throughout all areas or partial areas. Some requirements for high piled combustible storage dictate the presence of fire sprinkler systems.

Partial - Storage Areas. Indicate whether the partial fire sprinkler protection will include all high piled storage areas or not.

ESFR System. For those high piled storage areas that will utilize fire sprinkler protection, indicate if the sprinkler system protection being provided will be an ESFR system. See definitions section for a definition of ESFR. If the entire facility will be an ESFR system throughout, check "Throughout" then, "Yes" for ESFR.

- Item 14. **Fire Alarm System.** Indicate whether a fire alarm system is present in the facility or not. A security and/or burglar system that may incorporate a few smoke detectors does not count. The fire alarm system will incorporate smoke detection, heat detection, manual fire alarm pull stations, horns, strobes, etc.

- Item 15. **Piled Storage Information.** Provide as detailed and accurate information as possible. This section only refers to commodities being stored on the floor (with or without the use of pallets) and stacked atop each other. No racks or shelves are used for pile storage.

Cubic Feet Per Pile. Provide the cubic feet for each high pile of combustible storage.

Maximum Pile Dimension. This measurement represents the longest side of a pile.

Maximum Pile Height. As measured from the floor to the top of storage in feet. If multiple piles with different heights are present, provide information for all piles.

Aisle Widths Between Piles. Typically the aisle widths will be either 4 or 8 feet wide. However other aisle widths are definitely possible. Indicate the smallest dimension on the questionnaire but ensure to show all aisle widths on the drawings. See Figure 21.

- Item 16. **Access Doors Provided.** - Access doors providing access from the exterior roadways and/or driveways directly into the high piled storage areas is what may be required. An exterior door that provides direct access into the high piled storage areas from a sidewalk does not meet this criterion. An access door from a roadway into an office which is adjacent to the high piled storage area also does not meet this criterion.

- Item 17. **Access Doors Keyed for Fire Department Use.** All access doors specifically into the high pile storage areas must have a method for gaining entry from the exterior of the facility. In the very least, a key lock must be present with the master key(s) located in the facilities' Knox™ box.

Knox™ Box Note. All warehouse facilities with fire detection/alarm and suppression systems installed require a Knox™ Box system installed in a fire department approved location. The Knox™ system is a safe and secure on-site key box for the fire department's use only. Lubbock Fire Rescue has sole access to the Knox™ box. Master keys, card keys and any other special access keys (to any fire protection system) are required in the Knox™ box. This permits safe entry and limited damage into your facility in the event of an emergency.

Names and Titles of Persons Responsible for Information Contained Within Questionnaire. Provide the names of the individuals who completed these forms, along with all applicable phone/fax numbers, in order to contact them for additional information, or to answer questions that may arise.

Storage Questionnaire - Plastic Storage (High Hazard Commodities)

Completely and accurately fill out the Plastics Storage Questionnaire. The questionnaire should be completed and signed by a person qualified to answer these questions correctly. The following is a breakdown of each section of the questionnaire and commentary explaining the information being sought.

Business Name. Please provide the name of the tenant/business which will be occupying the space intended for stocking of high piled combustible materials.

Business Address. The correct and complete address must be provided to insure the correct information is in our database and on the high piled combustible storage permit.

Business Telephone. Provide at least one daytime phone number for the business that can be used as a contact for any questions or concerns. If possible, include a fax number and a secondary number.

- Item 1. **Plastic Group Type.** Much like the importance of correctly classifying commodities, plastics require correct grouping. A few sections taken from the 2021 International Fire Code depicting the various groups of plastics and examples are provided for assistance.

Group A plastics. *Group A plastics are plastic materials having a heat of combustion that is much higher than that of ordinary combustibles, and a burning rate higher than that of Group B plastics. Examples of Group A plastics include, but are not limited to, the following:*

- ABS (acrylonitrile-butadiene-styrene copolymer)
- Acetal (polyformaldehyde)
- Acrylic (polymethyl methacrylate)
- Butyl rubber EPDM (ethylene propylene rubber)
- FRP (fiberglass-reinforced polyester)
- Natural rubber (expanded)
- Nitrile rubber (acrylonitrile butadiene rubber)
- PET or PETE (polyethylene terephthalate)
- Polybutadiene
- Polycarbonate
- Polyester elastomer
- Polyethylene
- Polypropylene
- Polystyrene (expanded and unexpanded)
- Polyurethane (expanded and unexpanded)
- PVC (polyvinyl chloride greater than 15 percent plasticized, e.g., coated fabric unsupported film)
- SAN (styrene acrylonitrile)
- SBR (styrene butadiene rubber)

Group B plastics. *Group B plastics are plastic materials having a heat of combustion and a burning rate higher than that of ordinary combustibles, but not as high as those of Group A plastics. Examples of Group B plastics include, but are not limited to, the following:*

- Cellulosics (cellulose acetate, cellulose acetate butyrate, ethyl cellulose)
- Chloroprene rubber
- Fluoroplastics (ECTFE, ethylene-chlorotrifluoroethyl-ene copolymer; ETFE, ethylene-tetrafluoroethylene copolymer; FEP, fluorinated ethylene-propylene copolymer)
- Natural rubber (nonexpanded)
- Nylon (Nylon 6, Nylon 6/6)
- PVC (polyvinyl chloride greater than 5-percent, but not exceeding 15-percent plasticized)
- Silicone rubber

Group C plastics. *Group C plastics are plastic materials having a heat of combustion and a burning rate similar to those of ordinary combustibles. Examples of Group C plastics include, but are not limited to, the following:*

- Fluoroplastics (PCTFE, polychlorotrifluoroethylene; PTFE, polytetrafluoroethylene)
- Melamine (melamine formaldehyde) henol VC (polyvinyl chloride, rigid or plasticized less than 5 percent, e.g., pipe, pipe fittings)
- PVDC (polyvinylidene chloride)
- PVDF (polyvinylidene fluoride)
- PVF (polyvinyl fluoride)
- Urea (urea formaldehyde)

This list should facilitate the identification in grouping plastic commodities into an A, B, or C group type. If difficulties still arise, contact the product manufacturer for the necessary information required to properly group the type of plastic the facility stores. Submit this information to the Lubbock Fire Marshal's Office for record.

Item 2. **Percentage of Plastic in Storage.** The percentage of plastics is a significant factor. The difference between percentages may be the difference in fire sprinklers within the facility. Therefore, an estimated percentage of plastic materials within the facility is required. Please note that this percentage of plastics is based on individual pallet loads/cartons or packages, and is a function of the volume or weight of the packaging method. For example, in a pallet load of bicycles, the amount of plastics (pedals, reflector, tires, handle bar grips, etc.) is actually very limited as compared to the metal (non-combustible) portions of the bicycle. The percentage of plastics in the pallet load of bicycles may be 25% or $\frac{1}{4}$ of the total weight or volume of the pallet. In another example of storing computers, the percentage of plastics may be as high as 75%, due to computers being mostly plastic, with some exceptions. Contact the Lubbock Fire Marshal's Office with any questions.

Item 3. **Plastic Group Type A Conditions.** If it has been determined that the plastics being stored are Group A plastics, then the following questions are required to be answered.

Expanded, Non-Expanded and Free Flowing. Check all variations that apply and refer to the definitions section within this document for explanations of each variation. Plastics will be one of these variations.

Packaging of Plastic. Check all variations present within the facility. Refer to the definitions section for assistance.

Plastic in Piles. Again, check all variations present within the facility. Refer to the definitions section for assistance. If the plastics are stored on racks, this subsection need not be answered.

Contact the Lubbock Fire Marshal's Office with any questions.

Names and Titles of Persons Responsible for Information Contained Within Questionnaire. Provide the names of the individuals who completed these forms, along with all applicable phone/fax numbers, in order to contact them for additional information, or to answer questions that may arise.