Protection of Rubber Tires and Rolled Paper Storage in NFPA 13

Seventh in a series

By: John D. Campbell, P.E., CFPS

The previous articles in this series have addressed Miscellaneous Storage, the General Requirements for Storage, and the protection of Class I through IV and Plastic/Rubber commodities using Control Mode/Density Area, Control Mode Specific Application, and Early Suppression Fast-Response protection schemes. In this article, protection of specific commodities will be addressed. The rules outlined in Chapter 12 (and covered in the second article of this series) still apply.

Previously, it was discussed that prior to determining the design criteria, one must answer the three essential questions: 1) What will be stored? 2) How will it be stored? And, 3) How high will it be stored? In these cases, the first question is already answered. The remaining two, however, are critical in the case of rubber tire storage. Tires can be stored on-side (where the holes are perpendicular to the floor) or on-tread (where the holes run parallel to the floor), and the higher they are stored, the greater the fire hazard. For rolled paper, a greater fire hazard exists as the fire can be deep seated in the roll, which shields the fire from water discharging from sprinklers. The lighter the paper weight, the deeper the fire can burrow into the roll. Knowing how high, as well as the orientation, of the rolls is critical in determining the appropriate levels of protection.

Chapter 18 of NFPA 13 addresses Rubber Tire Storage. Tires present a unique firefighting hazard in that rubber has a very high heat release rate, when burned, and due to how tires are stored, fire spreads easily from one tire to another. The tires also prevent water from penetrating to the seat of the fire due to their very shape. How tires are stored also plays a critical role in firefighting. Laced tires present an extremely challenging hazard to protect so on, with the tread of one tire set at an angle into the hole of the one below, and so on, effectively blocking water from penetrating to the tires below. Tires on side, or on tread, also present unique challenges. Knowing how the tires are stored is critical (question #2) in addition to how high they are stored (question #3).

If tires meet the definition of “miscellaneous tire storage” per Chapter 13, then the designer may use the design criteria outlined in Table 13.2.1 rather than the requirements of Chapter 18. In order, to utilize Table 13.2.1, the storage must be “incidental to the main use of the building.” In addition, “Storage areas shall not exceed 2000 ft² (186 m²). On-tread storage piles, regardless of storage method, shall not exceed 25 ft (7.6 m) in the direction of the wheel holes. Acceptable storage arrangements include (a) on-floor, on-side storage up to 12 ft (3.7 m) high; (b) on-floor, on-tread storage up to 5 ft (1.5 m) high; (c) double-row or multiple-row fixed or portable rack storage on-side or on-tread up to 5 ft (1.5 m) high; (d) single row fixed or portable rack storage on-side or on-tread up to 12 ft (3.7 m) high; and (e) laced tires in racks up to 5 ft (1.5 m) in height.”
If the storage is beyond the maximum limits for miscellaneous, then the criteria outlined in Chapter 18 must be used. The criteria is presented in Tables 18.4(a) and Table 18.4(b) for standard spray (control mode/density area) sprinklers, Table 18.4(c) for Control Mode Specific Application (CMSA) sprinklers, and Table 18.4(d) for Early Suppression Fast-Response (ESFR) sprinklers. Each type of sprinkler provides for adequate protection, provided that the storage arrangements are within the limitations outlined in each table. All the criteria presented in the table is based on actual test data. To try and protect tires in storage arrangements other than those addressed in the tables is beyond the scope of NFPA 13.

Regardless of the type of sprinkler used, it is important that protection be provided for the exposed steel columns within the building. With the extreme amounts of heat that can be generated with a tire storage fire, the columns could fail early on in the fire, causing the building to collapse. Protection can be provided by fire proofing (spray-on or encasement) of the column, or by providing sidewall sprinklers directed to one side of each column. One sprinkler is required for storage exceeding 15 ft up to 20 ft (4.6 m up to 6 m) in height, and two are required for storage exceeding 20 ft (6m) in height, with one at the top of the column and the other at the 15 ft (4.6m) level. Flow from the column sprinklers does not need to be included with the hydraulic calculations, and column sprinklers are not required for columns located within fixed rack storage areas protected by in-rack sprinklers.

Hose stream allowances for tire storage must be significantly higher than for Class I through IV commodities. As such, a minimum of 750 gpm (2835 L/min) is required in addition to the required demand for automatic sprinklers and foam systems. Duration requirements are also greater, with tire storage requiring a minimum duration of 3 hours. If the storage is on-floor up to 5 ft (1.5 m) in height, the hose stream allowance can be reduced to 250 gpm (946 L/min) with a corresponding reduction in duration to 2 hours. Where CMSA and ESFR sprinklers are utilized, the hose stream allowances and duration requirements are outlined in Tables 18.4(c) and Table 18.4(d).

High expansion foam can be used to reduce the required density by one-half, provided the minimum density is still .24 gpm/ft² (9.78 mm/min), or the use of high expansion foam is not required elsewhere by Chapter 18. This option could be expensive for new construction, though may be feasible in existing situations.

The protection of rolled paper is addressed in Chapter 19. The distinction here is crucial. Paper by itself would normally be a Class III commodity, but when stored in large rolls, it creates a more difficult fire hazard, as stated earlier. It is also important to know what kind of paper is being stored (heavyweight, mediumweight, lightweight or tissue), whether or not if it is wrapped (and how), and if it is stored vertically or horizontally. Tissue paper can only be protected using wet systems, horizontal storage of heavy- and mediumweight paper must be protected as a closed array, and wrapping of rolls completely (both ends and sides – or sides only with steel bands) allows for lighter weight paper to be protected as heavier weight paper.

As with tires, if the rolls are stored no higher than 10 ft (3.1 m) in new construction, then the rules of Chapter 13 apply. Heavyweight and mediumweight classes are to be protected using Ordinary Group 2
densities, and tissue and lightweight paper classes are to be protected using Extra Hazard Group 1 densities. Otherwise, the requirements addressed Tables 19.1.2.1.3(a) and 19.1.2.1.3(b) must be used for control mode/density area applications. For existing systems, sprinkler protection must be in accordance with Tables A.19.1.2(a) and A.19.1.2(b). In all cases, high-temperature sprinklers are required when rolls are stored 15 ft (4.6 m) or higher (or an increase of the design area by 67% may be required), and the sprinkler coverage area cannot exceed 100 ft² (9.3 m²).

As also with tire storage, the use of high-expansion foam permits a reduction in the required density to no less than .24 gpm/ft² (9.8 mm/min) over the most remote 2000 ft² (186 m²) for heavyweight and mediumweight classes. If tissue or lightweight classes are to be protected with foam, the minimum densities cannot be lower than those provided in Tables 19.1.2.3(a) and 19.1.2.1.3(b).

CMSA and ESFR protection can also be used for the protection of rolled paper. Table 19.1.2.2 outlines the requirements for CMSA, but does not indicate the requirement for high-temperature sprinklers and 19.1.2.1.4 does not apply to CMSA sprinklers. It is up to the designer to utilize his/her best judgment. ESFR protection criteria is addressed in Table 19.1.2.3 is to be applied to 12 operating sprinklers and also is not subject to the high-temperature sprinkler requirement.

Hose stream allowances for rolled paper storage are 500 gpm (250 gpm for ESFR) and must be included with the sprinkler system demand in the hydraulic calculations. Water supplies must be capable of supplying the required design (including hose streams and foam, where required) for 2 hours (1 hour for ESFR).

Next: Chapter 20 – Special Designs of Storage Protection (last in the series)