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Don't Forget the Dry System

With all the buzz of antifreeze systems in the past months, alternatives are being sought to protect fire sprinkler systems from cold temperatures. The dry pipe sprinkler system should not be overlooked as it can adequately protect many arrangements. Dry pipe systems have been used for decades with great success of controliing fires in areas subject to temperatures less than 40°F (4°C).

Dry pipe sprinkler systems are used in a wide variety of areas. For example, loading docks, attics, freezers, canopies, outside walkways, and more recently even residential spaces can be protected with a dry sprinkler system. This article will be split into residential and non-residential applications of dry pipe sprinkler systems. Unless otherwise noted throughout this article, section references for NFPA 13, NFPA 13R, and NFPA 13D are based on the 2010 editions.

Residential System Applications

With dwelling units as the focus of the TIAs issued on NFPA 13, NFPA 13R and NFPA 13D on August 5, 2010, residential systems will be discussed first. It is important to note that all three sprinkler installation standards can apply to residential occupancies. The differences between them related to dry residential sprinkler systems will be noted as they come up in this article. Within the subject of dry residential sprinkler systems, there are a few main topics to discuss. These are residential sprinklers, dry pipe valves, water delivery time, and hydraulic calculations.

Residential sprinklers used in a dry system application must be listed specifically for dry systems. This means they have passed the standard residential sprinkler criteria and a fire test with a 15-second water delay to simulate the expected delay in water arrival from a dry pipe sprinkler system. Special listings do come with special requirements that need to be followed to ensure the product is used appropriately. The current residential sprinklers listed for dry residential systems on the market are available from only one manufacturer and require that a specific package for that application is used. This package includes the control panel, system gauges, compressor and dry pipe valve. The installation instructions for the package refer to NFPA 13D, which is the intended application for the package.

If the system is installed under NFPA 13, residential sprinklers are only an option for protection. This means that quick response standard spray sprinklers could be used in the area subject to low temperatures. The rules for standard spray sprinklers would apply for spacing, obstructions, and hydraulic calculations. This would also mean that any listed dry pipe valve could be used for the system. For the use of dry systems in NFPA 13R, the user is referred to the requirements of NFPA 13 so the same guidelines would apply.

Dry pipe valves are a necessary component in the dry pipe sprinkler system. When following NFPA 13, or NFPA 13R, there are dry pipe valves readily available from 1 ½ inch through 8-inch diameters. They operate on the differential of air versus water pressure, above and below the dry pipe valve clapper respectively. When the air pressure releases through one or more open sprinkler the valve can open and water will flow into the system.

The time it takes water to arrive at a sprinkler is comprised of two pieces. The first is the "trip" time. This is the time from the sprinkler operation while enough air evacuates the piping until the dry pipe valve opens allowing water to flow into the system. The second piece is "transit" time. This is the time it takes water to travel from the dry pipe valve to the open sprinkler(s). For dry residential systems the total water delivery time (trip + transit) is limited to 15 seconds for dwelling units. This small value will in turn help to keep the dry system size small and water delivery quick.

In residential occupancies there can be areas outside the dwelling unit that still need fire sprinkler protection and may need to be protected from low temperatures. For NFPA 13 and NFPA 13R, areas that are outside a dwelling unit would apply the requirements in NFPA 13. This means fast response sprinklers, other than residential types, could be used to protect the space. When the area is out-

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side a dwelling unit the water delivery requirements will also change. There are options, based on the size of the system and the hazard it protects, that correlate to the water delivery in a dry system.

The water delivery time is really a practical limitation on the system size so that the application of water on a fire is fast. There are two requirements that allow for a dry pipe system to deliver water to the inspector's test connection (ITC) without a limit. The first is a dry pipe system that is 500 gallons (1893 L) or less. The second is to keep the system to 750 gallons (2839 L) or less and use a quick-opening device on the system. The quick-opening device is either an accelerator or an exhauster. Both of these devices are intended to assist in removing air from the system so that the dry pipe valve will trip faster and allow water into the piping sooner. However, Section 7.2.3.1.1 prohibits systems that protect dwelling units to use these sizes and limitations, but they can be used if the system is only protecting areas other than the dwelling unit(s).

If the two cases above do not apply, then the base requirement is for water to be delivered to the ITC in 60 seconds or less. This value has long been used by NFPA 13. Yet now there are two other options instead of the 60-second rule. Both alternatives rely on a delivery time in accordance with the values shown in Table 1 (similar information is provided in Table 7.2.3.6.1 of NFPA 13). The values in the table allow for more than one sprinkler to be open in higher hazards where it is typical to find more than one sprinkler open in that type of fire scenario based on the anticipated heat release rates. The first method to achieve the water delivery time is to use a listed calculation program and method. The system layout is input into the program and the calculation run to provide a water delivery time. The second method is to build a manifold outlet to simulate the appropriate number of sprinklers (and arrangement of the sprinklers detailed in Section 7.2.3.7) open for the hazard the system is protecting. With the system at normal air pressure the manifold is opened and water delivery is timed.

Table 1: Alternative Dry System Water Delivery Times

Hazard Classification	Number of Open Sprinklers	Maximum Permitted Water Delivery Times
Residential	1	15 seconds
Light	1	60 seconds
Ordinary	2	50 seconds
Extra	4	45 seconds
High Piled	4	40 seconds

For areas protected with a dry pipe residential sprinkler system including dwelling units, the number of sprinklers that need to be hydraulically calculated will vary with which installation standard is being used. Starting with NFPA 13D, the standard calculation is up to two (2) sprinklers in a compartment (Section 8.1.2). The annex cautions against scenarios that were not specifically considered in the listing process. However, it is silent on needing additional sprinklers for a dry system arrangement. This leads to the manufacturer's cut sheets for dry residential sprinklers. Those currently on the market do not require additional sprinklers to be added to the calculation. It is important to note that under the dry residential sprinkler listing the flows may be slightly larger as a larger fire is expected by the time water arrives to the sprinkler. If a residential sprinkler has been listed for both wet and dry applications, then it is vital to make sure the correct flow is selected for the dry system calculations.

Next, NFPA 13R refers the user to NFPA 13 for dry systems so the calculations will be the same for both documents. If the system uses residential sprinklers, then a four-sprinkler calculation is necessary. The flow rate will be either the listed value or 0.1 gpm/ft^2 (4.1 mm/min), whichever is greater. If the manufacturer's installation criteria indicate more sprinklers need to be calculated that would govern. Yet those currently listed do not require additional sprinklers for the calculations.

When areas outside the dwelling unit(s) are calculated for the water supply of a dry system under NFPA 13 or NFPA 13R, the calculation procedure is that discussed in the "Non-Residential System Application" portion of this article.

Non-Residential System Applications

When using a dry pipe system for occupancies other than residential, the same topics are important. The types of sprinklers used, the system valve, the water delivery time, and hydraulic calculations all need to be discussed. For this section, only NFPA 13 applies as this is non-residential applications for dry sprinkler systems.

Starting with the types of sprinklers for a dry system, the use of pendent sprinklers is limited. This is for two reasons. First, through the life of the system, sediment, rocks, scale and other debris could collect in these drops. Second, if the area reaches freezing temperatures, ice plugs could form. Either of these situations could be detrimental to the correct operation of the fire sprinkler system. Return bends are an option for using pendent sprinklers where the sprinkler and return bend are kept in a heated area.

Another option for a pendent sprinkler is to use a listed dry pendent. A dry type of sprinkler is connected to a wet pipe system but has a barrel that remains dry to transition to the colder space. These are also available in sidewall styles. The length needed is specified when the sprinkler is ordered, based on the lengths needed for penetration of the physical barriers and/or

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to maintain the appropriate temperatures. Because each one is prepared to order, the cost for dry sprinklers is significantly higher than traditional models. Therefore, these sprinklers are used when a majority of the building can be protected with a wet system and specific areas utilize the dry sprinklers, such as a walk-in cooler or freezer that needs a single sprinkler for protection and the remainder of the building is protected with a wet system.

When the area is not residential, typical upright and sidewall sprinklers are used on a dry system. There is no special listing required, just the standard testing that is required of all sprinklers. The ease of upright and sidewall sprinklers to be drained to the dry condition simply allows for them to be used without changes from the common models.

A dry pipe valve is necessary to hold the water back from entering the system until it is needed. These valves are listed. As noted earlier, those on the market range in size from 1 ½ inch diameters through 8-inch diameters. The area where the valve is installed must be heated so that the water below the valve remains liquid.

Water delivery time is just as important a characteristic for systems in non-residential occupancies as those of residences. However, the requirements explained above for areas that are outside the dwelling units are the same for non-residential occupancies. There are the five options for sizing the system. Two of which allow open ended delivery times based on the system volume. The remaining three options have limitations based on the time for water to reach the ITC either by calculation or physical test.

The hydraulics of a dry system that does not include dwelling units has two options. The first is the room design method. Section 11.2.3.3 details the requirements for using the room design method. The basic concept is all of the sprinklers in a compartment are calculated. This is the same whether the system is wet or dry. The second method is the density/area method covered in Section 11.2.3.2. When applying this method to a dry system, the area must be increased by 30 percent (Section 11.2.3.2.5). This means that if the selected area from the density/area figure was 1500 ft² (139 m²) it would be increased by 30 percent to 1950 ft² (181 m²), then the 1950 ft² (181 m²) area would actually be calculated.

Summary

In general, dry sprinkler systems are a great way to protect the system from freezing conditions. Although the water arrival to the fire is delayed, it can still control a fire when adequately designed under the dry system criteria. The extension to use dry systems in dwelling units does need special attention, but can be done. In some cases, sprinklers have additional criteria that needs to be followed as they are listed for special scenarios, such as dry pendent sprinklers or dry residential sprinklers.

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