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# A Technical Analysis: The Use and Maintenance of Dry Type Sprinklers

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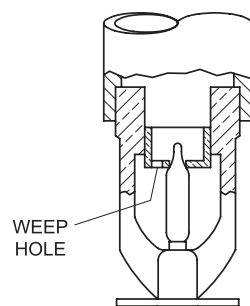
## INTRODUCTION

Dry type sprinklers are usually installed in relatively harsh environments where temperature, humidity and corrosive conditions are prevalent. These conditions may contribute to a life expectancy that is less than normal for standard sprinklers. Tyco Fire & Building Products has performed an extensive analysis of the design, use and maintenance of dry type sprinklers. As a result of the study, several issues have been identified and those issues have been addressed with Tyco Fire & Building Products' new product offering. These issues include ice buildup inside dry type sprinklers; ice development in wet system branch lines due to conduction; and obstruction of water flow by the inlet seal.

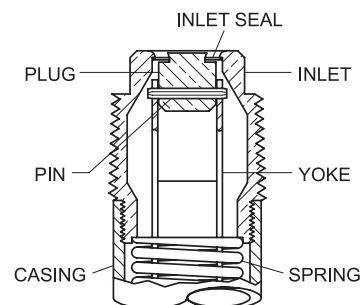
As such, where any of the following issues are experienced and replacement sprinklers are needed, the new product line as manufactured by Tyco Fire & Building Products under the brand names of Central, Gem, and Star should be specified.

## BACKGROUND

A dry type sprinkler is a type of sprinkler that is used to provide sprinkler protection in unheated areas or areas that are exposed to low temperatures such as docks, unheated areas of buildings, or freezers. Dry type sprinklers are available in a variety of finishes in upright, pendent, and sidewall styles. The dry type sprinkler consists of a sprinkler permanently attached to the outlet of an extension pipe nipple. The sprinkler contains a required "weep" hole (or annular clearance) at the seat as a means of identifying water leakage past the inlet seal (**see Figure 1**). The pipe nipple is sealed at the inlet to prevent water from entering the nipple until the sprinkler operates (**see Figure 2**). The inlet end of the dry type sprinkler is installed into a threaded tee fitting, typically above a ceiling or enclosure.



**FIGURE 1**  
TYPICAL SPRINKLER  
OUTLET



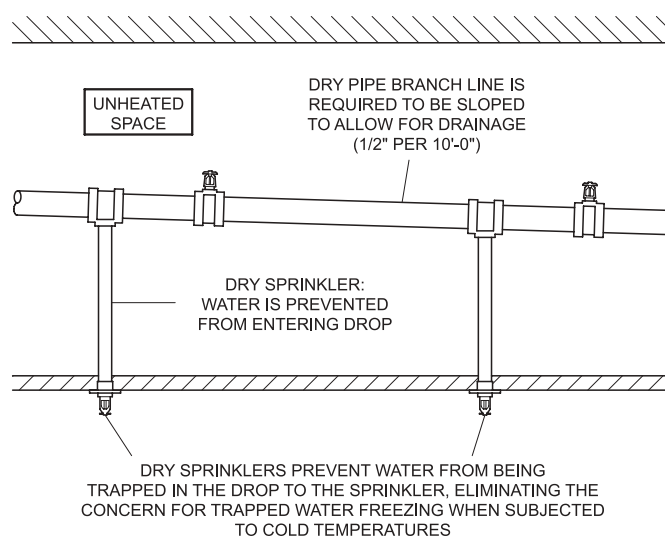
**FIGURE 2**  
TYPICAL INLET SEAL  
CONFIGURATION

## CONCEPT

The concept of a dry type sprinkler is simple and can be explained by the following two primary uses:

### 1. Dry Pipe Systems (see Figure 3)

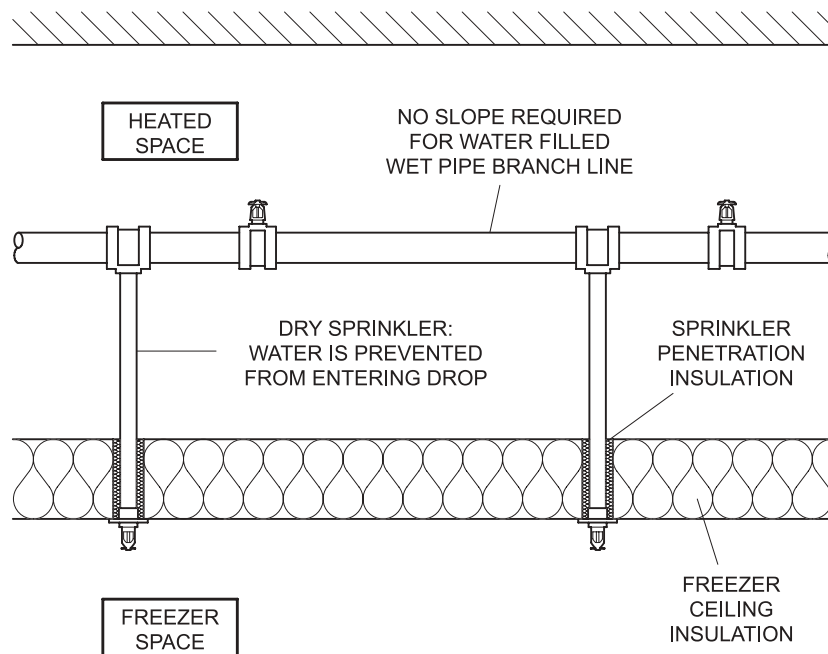
These systems are found in environments where the air temperature is at or below 40°F (4°C). Generally, upright sprinklers, located on the top of the branch line are used on dry systems because these types of sprinklers do not trap water. The piping of a dry pipe system (normally charged with air pressure) is required to be sloped to facilitate drainage. This will allow the drainage of either condensation inside the pipe or drainage of the water after the system fills due to a valve trip or system inspection test. A standard pendent sprinkler on dry systems would trap water in the sprinkler and fitting to which it is attached. The trapped water would have the potential to freeze and to cause mechanical damage to the sprinkler or prevent the sprinkler from operating during a fire. To prevent water from accumulating and potentially freezing in a drop to a sprinkler on a dry pipe system, and to eliminate the necessity of draining the drops and removing sprinklers installed in the pendent position after the dry pipe valve has tripped, dry type sprinklers are used.



**FIGURE 3**  
TYPICAL INSTALLATION  
ON DRY PIPE SYSTEM

**2. Wet Pipe Systems (see Figure 4)**

The dry type sprinkler can be used in conjunction with a traditional wet pipe system (a system in which the piping is filled with water at all times) when the sprinkler piping is in a heated area and the sprinklers are installed in an area subject to freezing. These areas can include loading docks, attic spaces, and walk-in freezers.

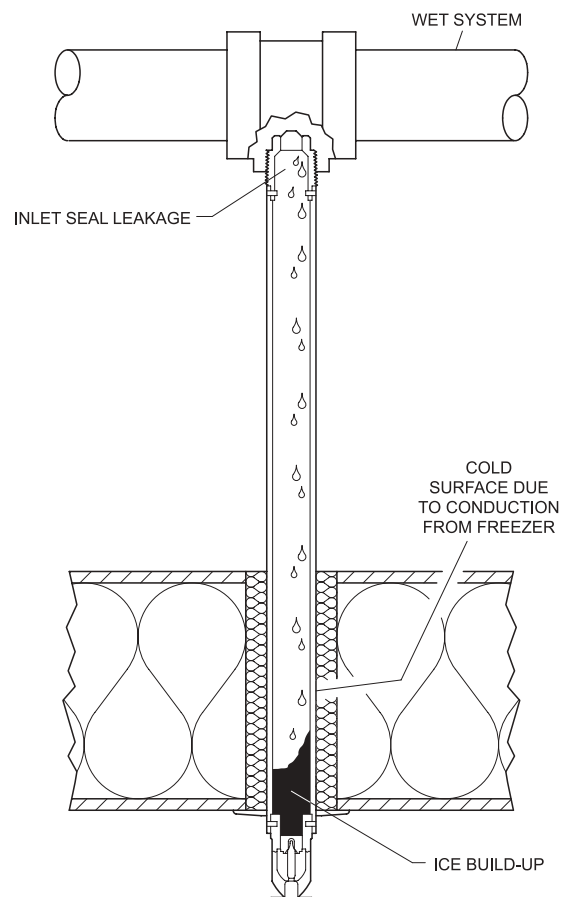


**FIGURE 4**  
TYPICAL INSTALLATION  
ON WET PIPE SYSTEM

## ICE BUILDUP INSIDE DRY TYPE SPRINKLERS

The potential for ice buildup inside dry type sprinklers has become evident in some older model designs of various manufacturers. This buildup can cause mechanical damage to the sprinkler and possibly cause false sprinkler activation. The ice is normally formed by either of two conditions:

1. Leakage of water past the inlet seal assembly: Water enters the dry type sprinkler at a faulty inlet seal and runs down the inside of the dry type sprinkler barrel, freezing upon contact with the colder air and metal barrel of the dry type sprinkler (see **Figure 5**).



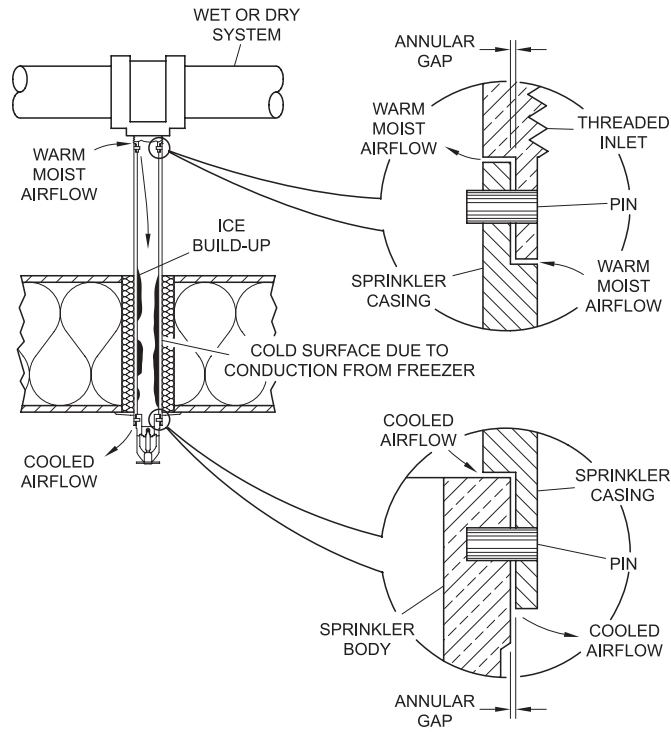
**FIGURE 5**  
ICE FORMATION - INLET SEAL LEAKAGE

2. Air interchange: Distinctive to freezer applications, air interchange occurrence is caused by warm moist air entering the dry type sprinkler through any annular opening that may be present at the inlet end of the dry barrel (**see Figure 6**). This warm moist air from the heated area then condenses inside the barrel as the air is cooled while flowing through the dry type sprinkler and into the freezer. Airflow through the dry type sprinkler is caused by a pressure differential between the area above the freezer and inside the freezer. The pressure differential can be created when the freezer doors of smaller walk-in freezers are opened and closed. The freeze and thaw cycles that freezers typically experience several times each day may also create a pressure differential. This condition would typically not occur with dry type sprinkler installations in externally cold environments such as parking garages where pressure differentials are not be encountered.

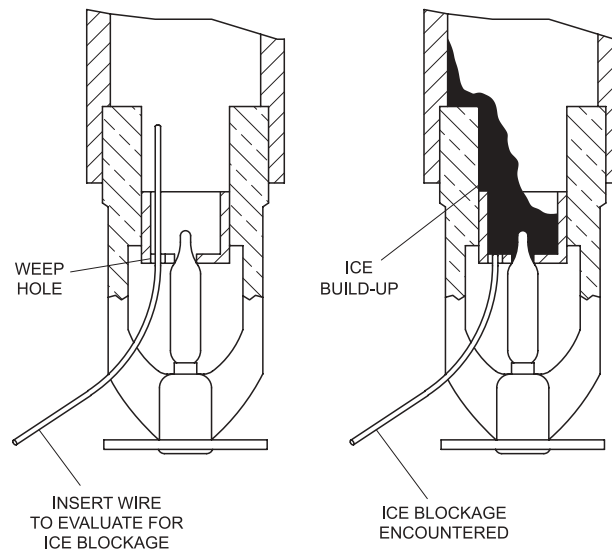
Ice build-up can be recognized by a simple field test during regular maintenance inspections. A light gauge wire can be carefully inserted through the "weep" hole as shown in **Figure 7**. If the wire meets resistance inside the hole, a strong possibility exists that an ice plug has been formed and replacement of the dry type sprinkler should take place. Tyco Fire & Building Products recommends that where evidence of ice buildup is present, sprinklers should be replaced.

Tyco Fire & Building Products has evaluated the potential causes of internal ice build-up and has incorporated design enhancements to eliminate air interchange and leakage potential. The "weep" hole is still required to show signs of leakage from the water seal; however, all other areas susceptible to air interchange have been sealed, thus eliminating the possibility of icing from this source. Tyco Fire & Building Products has also incorporated the Belleville seal to reduce the possibility of leakage at the inlet seal.





**FIGURE 6**  
ICE FORMATION - AIR EXCHANGE

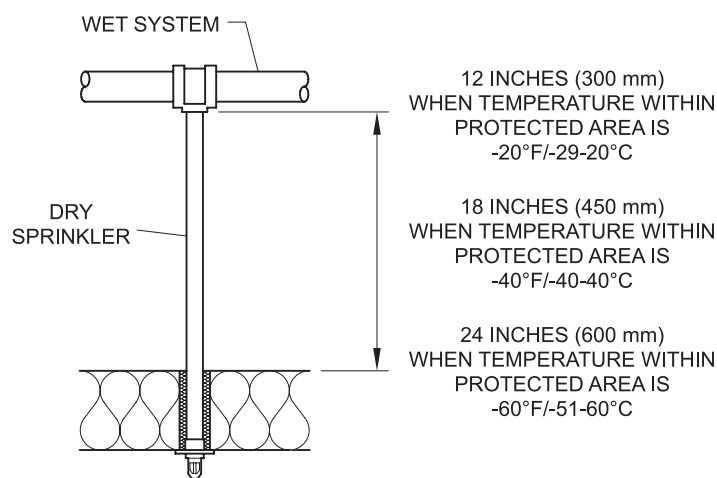


**FIGURE 7**  
FIELD TEST FOR ICE BLOCKAGE

ICE DEVELOPMENT IN WET SYSTEM BRANCH LINES DUE  
TO CONDUCTION

Conduction is a process that transfers freezing temperatures around a sprinkler, through the metallic piping components of a dry type sprinkler, to the water filled piping connection. This is only a concern in wet piping systems supplying dry type sprinklers that are exposed to freezing temperatures.

This transfer of cold temperatures has the potential to freeze the water above the inlet to the dry type sprinkler, forming an ice plug. Ice plugs above the inlet of dry type sprinklers cause excessive pressures to the seal of the dry type sprinkler as well as to the fitting to which the sprinkler is connected. These ice plugs cannot be detected by field inspection. Some ice plugs are strong enough to cause mechanical damage to the inlet seal of the dry type sprinkler, and in some cases cause a false activation. Damage to the seal can also lead to internal icing as previously discussed. Ice plugs can also affect water flow in the event of a fire, either to the dry type sprinkler, or to any sprinklers in the heated area that may be downstream of the ice plug.



**FIGURE 8**  
MINIMUM EXPOSURE LENGTH

Consideration must be given to the appropriate length of a dry type sprinkler to prevent freezing of water in a wet system due to conduction. Minimum distances should be designed and maintained between the barrier (usually a ceiling or a wall separating the freezing temperatures from the wet pipe system) and the connection to a wet-pipe sprinkler system to prevent the possibility of freezing due to the conductance of cold temperatures to the water in a wet pipe sprinkler system. For this reason it is imperative that the minimum dry type sprinkler lengths published by the sprinkler manufacturer be followed. Some manufacturers may not publish minimum lengths and rely on the published guidelines of agencies such as Factory Mutual for recommended minimum distances between freezing exposures and wet piping connections. Tyco Fire & Building Products has performed additional testing on its products with various temperature exposures both to the sprinklers and the ambient air temperature to which the wet piping system is exposed. Based on the results of testing, Tyco Fire & Building Products recommends adherence to its published guidelines for its dry type sprinklers rather than relying on the guidelines published by Factory Mutual.

When the temperature surrounding the wet pipe sprinkler system is maintained at a minimum temperature of 40°F/4°C, Tyco Fire & Building Products recommends the following minimum lengths (**see figure 8**) between the face of the sprinkler fitting and the outside surface of the unheated area.

## **OBSTRUCTION OF WATER FLOW BY THE INLET SEAL**

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Tyco Fire & Building Products' extensive analysis of dry type sprinkler issues has also revealed an inherent deficiency in the current visual examination testing protocol for dry sprinklers. This testing protocol fails to adequately detect water flow obstruction since all internal sprinkler parts cannot be observed. As a result, a dry sprinkler can satisfy current testing standards yet fail to meet published K-factor values.

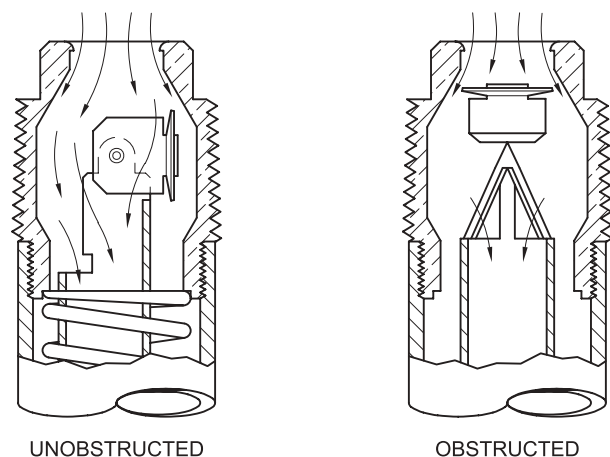
The Listing agencies test for obstruction of water flow (lodgment) is by conducting a visual examination of the dry sprinkler after activation. A visual examination is made of the flowing sprinkler for verification that all of the operating parts have cleared the sprinkler, providing an unobstructed flow of water. Unfortunately, this visual examination is not able to verify that the inlet seal has cleared the waterway as intended because the inlet seal is not visible during this test. If the inlet seal has not

cleared the waterway, this creates a potential obstruction issue that can significantly reduce the published K-factor values of dry type sprinklers. These reduced K-factors do not fall into the published values by other manufacturers or the range specified by NFPA 13. Since the actual flow through the sprinkler is much less than that for which the system was designed, this ultimately results in minimum design densities that are less than those for which the system was calculated.

The water flow obstruction issue identified above is more than just a hypothetical one; Tyco Fire & Building Products found that the Belleville seal in some other manufacturers' models does not rotate and clear the waterway of the sprinkler as intended when the sprinkler activates. Instead of rotating out of the waterway, the water flow creates a hydraulic balance in the Belleville seal and supporting structure, preventing the seal from clearing the waterway as intended (see **Figure 9**). The Belleville seal then obstructs the water flow through the sprinkler causing a reduction the actual K-factor of the dry type sprinkler.

The construction of Tyco Fire & Building Products' dry pendent sprinklers ensures that the inlet seal mechanism will clear the waterway of the sprinkler, as designed. The 5.6 K-factor dry type sprinklers employ a coil spring that moves the inlet seal offset from the waterway centerline after the sprinkler operates. This action rotates the inlet seal and clears the sprinkler waterway. The 11.2 K-factor dry type sprinkler utilizes the same construction as the 5.6 K-factor dry type sprinklers and is provided with an additional spring that assists the rotation of the inlet seal.

The visual examination testing protocol should be improved by measuring the water flow during the obstruction (lodgment) test. This will verify that the inlet seal has properly cleared the waterway as intended. We believe other manufacturers may not be aware of this problem since the current laboratory approval testing standards will not identify this problem.



**FIGURE 9**  
INLET FLOW COMPARISON

**CONCLUSION**

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Tyco Fire & Building Products strongly recommends maintenance and inspection in conformance with NFPA 25, Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems.

If ice build-up inside dry pendent sprinklers is discovered during the maintenance inspection, we recommend contacting the manufacturer or installing contractor regarding the replacement of the sprinklers.

In order to prevent ice development in the sprinkler branch line due to conduction, care must be given to selecting the appropriate dry type sprinkler length. Always incorporate the manufacturer's recommended minimum lengths during design of the sprinkler system.

If concerns arise regarding a manufacturer's dry type sprinklers becoming internally obstructed due to the internal operating parts not clearing the sprinkler waterway, contact the manufacturer regarding their designs.

Tyco Fire & Building Products has performed extensive investigations of current dry type sprinklers and dry type sprinkler technology in order to address and fully understand the multiple issues inherent with these special sprinklers and their installed environments. As a result, we firmly believe we now manufacture the finest, most robust dry type sprinklers in the industry.

Providing a mechanically sound dry pendent sprinkler that must be counted on to properly activate and discharge appropriate volumes of water in the event of a fire is a must. The new product line offered by Tyco Fire & Building Products accomplishes these critical objectives, and they should be the product of choice when specifying these unique and special sprinklers.

## ABOUT THE AUTHOR

### **JAMES E GOLINVEAUX**

Senior Vice President, Research & Development

Mr. Golinveaux's areas of interest include the research, design and applications of automatic fire sprinklers as well as their history. His interest in the fire sprinkler industry was sparked by his father's 27 years in the fire service.

Beginning as a designer in the early 1980's and later as a design manager for a fire protection firm in California, he applied local and national standards to develop working drawings for automatic fire sprinkler systems. Mr. Golinveaux became active and continues his involvement today through his membership on numerous committees such as the National Fire Protection Association (Member of NFPA 13 Discharge & Installation), International Conference of Building Officials, Society of Fire Protection Engineers and Southern Building Code Congress International. By 1991, Mr. Golinveaux's strong application knowledge of the automatic fire sprinkler industry afforded him the opportunity to work on the East Coast as the Director of Technical Services for Central Sprinkler Company. Mr. Golinveaux was responsible for the technical responses to worldwide production of automatic fire sprinkler system components. He continued his involvement in the industry and represented Central on many national committees including the National Fire Protection Research Foundation, Research and Advisory Council on Fire Suppression Futures and Underwriters Laboratories Industry Advisory Committee for automatic sprinklers. Mr. Golinveaux's many talents and wealth of knowledge were recognized by Central where he was Senior Vice President of Engineering and was directly responsible for the Production Plant with over 600 employees, the Engineering/R & D, Quality Control and Technical Services operations. Currently, Mr. Golinveaux is Senior Vice President of Research and Development for Tyco Fire & Building Products, which represents Central, Gem and Star branded products.

In addition to the support of the industry through his numerous committee memberships, Mr. Golinveaux also contributes his time as a speaker for national education seminars sponsored by organizations such as the Society of Fire Protection Engineers, Universities, Highly Protected Risk (HPR) Insurance Companies, National Apprenticeship and Training, and Trade Associations as well as state and local fire authorities. He has educated many on the latest sprinkler technology and its associated codes and standards.

Mr. Golinveaux's co-authored the published article "*Fire Test Performance of Extra Large Orifice Sprinklers in Rack Storage of Group A Plastics in Warehouse-Type Retail Occupancies.*" He is also named on numerous U.S. Patents relating to automatic sprinklers.



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