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TechNotes

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This Special Edition of TechNotes is an annual reissue of the information relevant to protecting fire sprinkler systems from freezing as cold temperatures are again upon us. It was prepared and updated by Bob Upson, NFSA's Manager of Engineering Services.

Special Winter Edition 2018

Once again winter is almost upon us and it's time to think about how we can protect sprinkler systems from freezing. For some parts of the country, the cold weather is already settling in and systems are being challenged by adverse conditions. As we all bundle up to endure the cold, it is a good time to remind everyone of the rules for fire sprinkler systems subjected to cold temperatures.

Before reviewing cold weather concerns overall, there's one question that can be answered right away: No, there is still no antifreeze available on the market listed for use in fire sprinkler systems. That being said, let's review cold weather issues.

Cold temperatures start to be a concern for water-based fire protection systems at around 40°F (4°C) because this is the temperature where fresh water starts to form ice crystals which can progress quickly to freezing as the temperature is lowered to 32°F (0°C) (Lide 2005). The first option available to system designers is to use a dry-pipe system so that there is no water in the pipes to freeze:

> ***8.16.4.1.1**** *Where any portion of a system is subject to freezing and the temperatures cannot be reliably maintained at or above 40°F (4°C), the system shall be installed as a dry pipe or preaction system. (NFPA 13)*

It is clear from the opening paragraph of the NFPA 13 Annex A commentary about dry-pipe systems that the informal consensus among the technical committee is that they should only be installed where they are the best alternative available. Dry pipe systems have their own advantages and disadvantages and can be especially tricky in systems serving residential areas due the complications of meeting

the requirements for 15-second or less water delivery time (NFPA 13, 7.2.3.6.3, NFPA 13R, 5.4.3, NFPA 13D, Table 9.3.3.1).

> ***A.7.2*** *A dry pipe system should be installed only where heat is not adequate to prevent freezing of water in all parts of, or in sections of, the system. Dry pipe systems should be converted to wet pipe systems when they become unnecessary because adequate heat is provided. Sprinklers should not be shut off in cold weather.*
> *Where two or more dry pipe valves are used, systems preferably should be divided horizontally to prevent simultaneous operation of more than one system and the resultant increased time delay in filling systems and discharging water and to prevent receipt of more than one waterflow alarm signal.*
> *Where adequate heat is present in sections of the dry pipe system, consideration should be given to dividing the system into a separate wet pipe system and dry pipe system. Minimized use of dry pipe systems is desirable where speed of operation is of particular concern. (NFPA 13)*

When a dry-pipe system is not the desired solution to cold temperatures, the installation standards all provide basically the same general alternatives for protection against freezing:

- Antifreeze systems (NFPA 13, 8.16.4.1.2, NFPA 13D, 9.1.2(2))
- Insulated coverings (NFPA 13, 8.16.4.1.3)
- Heat-tracing systems (NFPA 13, 8.16.4.1.4, NFPA 13D, 9.1.2(4)*)
- Dry sprinklers (NFPA 13, 7.7.3.4, NFPA 13D, 9.1.2(3) & 9.1.2(5))
- Heat loss calculations (NFPA 13, 8.16.4.1.5)

Antifreeze Systems

Listed Antifreeze Solutions
With just a few exceptions, all three sprinkler installation standards require the use of listed premix antifreeze solutions (NFPA 13, 7.6.2.1, NFPA 13R, 5.4.2*(1)*, NFPA 13D, 9.2.2.1) and, at present, there are no listed antifreeze solutions available. As a result, antifreeze will not be a viable design option in most new sprinkler systems until products listed specifically for use in fire sprinkler systems come on the market. A listing standard, UL 2901, has been available through Underwriters Laboratories (UL) since December 19, 2013, the scope is noted below. To reiterate; NFSA is not aware of any listed antifreeze solutions as of the publication date of this article.

> 1.1 This Outline of Investigation covers requirements for the performance of antifreeze solutions for fire sprinkler systems.

Did You Know??

The NFSA keeps a member of the Engineering Department staff on duty every business day to answer your technical questions live. We call this the Expert of the Day (EOD) program and it is available to our members by phone, fax or e-mail. Call us at (845) 878-4200 and press 2, or you can send a fax to (845) 878-4215, or you can e-mail us at eod@nfsa.org. Last year we answered more than 2600 requests for assistance.

1.2 These solutions are intended for use in wet pipe sprinkler systems subject to freezing for installation in accordance with the manufacturer's design and installation instructions and the Standard for Installation of Automatic Sprinkler Systems, NFPA 13; and inspected, tested and maintained in accordance with the Standard for Inspection, Testing and Maintenance of Water Based Fire Protection Systems, NFPA 25. (UL 2901 2013)

Premix Antifreeze Solutions

There has been some confusion with some premix antifreeze solutions marketed as "compliant with NFPA requirements". Typically, this indicates that the antifreeze is a premixed solution of a type, chemical purity, and concentration acceptable to the various installation standards and NFPA 25 - not that it is listed for use in new fire sprinkler systems. Care should be taken not to mistake premix solutions meeting the purity and concentration requirements for a listed product.

> ***3.6.4.1.1 Premixed Antifreeze Solution.*** *A mixture of an antifreeze material with water that is prepared and factory mixed by the manufacturer with a quality control procedure in place that ensures that the antifreeze solution remains homogeneous and that the concentration is as specified. [13, 2016]*
>
> ***5.3.3.4.2*** *Newly introduced solutions shall be factory premixed antifreeze solutions (chemically pure or United States Pharmacopeia 96.5 percent). (NFPA 25)*

Current Permissible Uses of Antifreeze
The following information details the limited areas where antifreeze can be used in new systems until a listed antifreeze solution is available, as well as regulations related to handling existing antifreeze systems.

Installing New NFPA 13 Systems
New antifreeze systems are required to use listed solutions under NFPA 13 (Standard for the Installation of Sprinkler Systems, 7.6.2.1). The one exception is that premixed antifreeze solutions of propylene glycol are permissible with specific ESFR sprinklers listed for such use in an application complying with the listing (NFPA 13, 7.6.2.2).

Maintaining Existing NFPA 13 Systems
The rules of new editions of NFPA 13 do not apply to existing systems installed under older editions. Maintenance of existing systems is generally performed in accordance with NFPA 25 which allows existing antifreeze systems that were installed under older editions of NFPA 13 to have the solution replaced with propylene glycol or glycerine with the following additional limitations from NFPA 25 (5.3.3.4):

5.3.3.4.1* *For systems installed prior to September 30, 2012, listed antifreeze solutions shall not be required until September 30, 2022, where one of the following conditions is met:*
(1) The concentration of the antifreeze solution shall be limited to 30 percent propylene glycol by volume or 38 percent glycerine by volume.*
(2) Antifreeze systems with concentrations in excess of 30 percent but not more than 40 percent propylene glycol by volume and 38 percent but not more than 50 percent glycerine by volume shall be permitted based upon an approved deterministic risk assessment prepared by a qualified person approved by the authority having jurisdiction.*

5.3.3.4.3 Premixed antifreeze solutions of propylene glycol exceeding 30 percent concentration by volume shall be permitted for use with ESFR sprinklers where the ESFR sprinklers are listed for such use in a specific application.

Installing New NFPA 13R Systems
New antifreeze systems are required to use listed solutions under NFPA 13R (Standard for the Installation of Sprinkler Systems In Low-Rise Residential Occupancies, 5.4.2) with no exceptions provided by the standard.

Maintaining Existing NFPA 13R Systems
The situation is the same as with existing systems installed in accordance with NFPA 13. See above.

Installing New NFPA 13D Systems
New antifreeze systems are permitted to be glycerine or propylene glycol if the antifreeze is limited to piping supplying a specific portion of the building subjected to freezing conditions and if the AHJ has been convinced that no other option is available (NFPA 13D, 9.2.2.2*). In these cases, they are permitted to use premixed glycerine solutions at a maximum concentration of 48% by volume or premixed propylene glycol solutions at a maximum concentration of 38% by volume.

Maintaining Existing NFPA 13D Systems
Systems installed in accordance with NFPA 13D do not need to meet NFPA 25 nor the rules discussed above. Instead, NFPA 13D has its own simplified requirements to deal with antifreeze in existing systems:

a) Listed antifreeze solutions are allowed for replacement in glycerine systems for up to 50% by volume premixed solutions and propylene glycol systems for up to 40% by volume premixed solutions (NFPA 13D, 9.2.2.1.1).

b) Unlisted antifreeze solutions are permitted with the same restrictions as those applied to new systems. These solutions are limited to 48% by volume premixed glycerine solutions and 38% by volume premixed propylene glycol solutions for pipe supplying sprinklers in

a specific area of the dwelling unit where acceptable to the AHJ (NFPA 13D, 9.2.2.2*).

Existing Antifreeze Systems Decision-Making Guide (Click on the image above for the full-page version)

Antifreeze Use in Jurisdictions Adopting 2007 or Earlier Editions of NFPA 13

Some jurisdictions still reference, as their legally adopted standard, the 2007 or earlier editions of NFPA 13 which still permits the use of unlisted antifreeze solutions in new sprinkler systems. The question sometimes arises, "Are there any special limitations for antifreeze systems where older editions of NFPA 13 permit their use?"

Our best answer to this question is: *Yes!* Based on the latest edition of the NFPA 13 installation standard, unlisted antifreeze solutions should not be used in new systems. The changes in the antifreeze requirements requiring listed antifreeze solutions were first introduced in the 2013 edition of NFPA 13 and were made retroactive to the 2010 edition by means of a Tentative Interim Amendment (TIA). It is rare for NFPA to process a TIA on documents other than the most current published edition. Although this issue is a large concern, the NFPA chose to only process the TIA on the 2010 edition, recognizing that the newer published editions represent the current positions based on research findings presented to the Committee. The 2013 changes remain in effect in the latest edition, 2016.

Although no official amendment has been made by NFPA to the 2007 or prior editions, it would be prudent not to ignore the information that is available. The hazard with antifreeze does not change depending on which edition of the standard is being used for installation purposes. Failure to acknowledge these limitations could create a potential liability as the information is readily available in the newer editions.

Some additional resources for information about the potential hazards associated with existing unlisted antifreeze solutions may be found in NFPA 13 (NFPA 13, Annex F):

> ***F.1.2.12 FPRF Publications.*** *Fire Protection Research Foundation, 1 Batterymarch Park, Quincy, MA 02169.*
>
> *Antifreeze Solutions Supplied through Spray Sprinklers - Interim Report, Fire Protection Research Foundation, February 2012*
> *Antifreeze Systems in Home Fire Sprinkler Systems - Literature Review and Research Plan, Fire Protection Research Foundation, June 2010*
> *Antifreeze Systems in Home Fire Sprinkler Systems - Phase II Final Report, Fire Protection Research Foundation, December 2010*

Antifreeze Alternatives

If antifreeze is not a viable option for your design scenario,

then one of these NFSA past "SQ" articles may offer assistance with information on alternatives to using antifreeze in a fire sprinkler system.

Dry-Pipe Systems

"Dont Forget the Dry System"

In general, dry sprinkler systems are a great way to protect the system from freezing conditions. Although the water arrival time is delayed, it can still control a fire when adequately designed under the dry system criteria. (Valentine 2011)

Insulated Coverings
"Antifreeze Alternatives - Tenting of Insulation"

Batt insulation can be effectively used in an attic space to protect sprinkler piping from freezing without the need for antifreeze solutions. The procedures for laying the insulation need to be carefully controlled, but the end result is an inexpensive and effective fire protection system... (Isman 2011)

Heat Tracing Systems

"Heat Tracing for Fire Sprinkler Systems"
Heat tracing can be used on risers and mains of fire sprinkler systems to prevent the piping from freezing. As of right now, heat tracing cannot be used on branch lines of fire sprinkler systems unless the heat tracing receives a special listing for this use, and we are unaware of any companies that have received this special listing. (Isman 2010)

Dry Sprinklers
"Dry Sprinkler Installation"

In several cases, sprinkler protection needs to be extended into spaces subject to freezing and a complete, separate, dry pipe or anti-freeze system is cost-prohibitive to install. .... The dry sprinkler connected to the wet system is the ideal device to cover small areas that are subject to freezing temperatures... (Hugo 2011)

Summary

As everyone tries to stay warm this winter, remember to keep the water of the fire protection systems warm, too, or at least 40°F (4°C)! The use of antifreeze in new systems will continue to be limited until a solution listed for use in fire sprinkler systems becomes available. Until that time, there are a variety of alternatives available to the sprinkler system designer.

Happy Holidays!

References

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NFPA 13D. 2015. Standard for the Installation of Sprinkler Systems in One- and Two-Family Dwellings and Manufactured Homes. 2016. Quincy, MA: National Fire Protection Association.

NFPA 13R. 2015. Standard for the Installation of Sprinkler Systems In Low-Rise Residential Occupancies. 2016. Quincy, MA: National Fire Protection Association.

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Valentine, Victoria B. 2011. "Don't Forget the Dry System." SQ, January/February: 26-28.