NFSA NATIONAL FIRE SPRINKLER ASSOCIATION
The Voice of the Fire Sprinkler Industry

TechNotes

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Freeze Protection - Special Edition

This Special Edition of TechNotes is an annual reissue of the information relevant to protecting fire sprinkler systems from freezing as the seasons begin to change and as parts of the country are already seeing their first frost. It has been prepared by Kevin Hall, P.E., NFSA's Manager of Engineering Research.

The requirements for protecting sprinkler pipe against freezing are contained within section 16.4.1 of NFPA 13-2019:

> ***16.4.1 Protection of Piping Against Freezing.***
> ***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.*
> ***16.4.1.1.1*** *The requirements of 16.4.1.1 shall not apply where alternate methods of freeze prevention are provided in accordance with one of the methods described in 16.4.1.2 through 16.4.1.4.1.*

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. While the first option mentioned in the standard is to use a dry or preaction system, this TechNotes will focus on the ways to protect wet pipe systems from freezing. The installation standards allow the same general alternatives for protection against freezing:

1. Insulated coverings (NFPA 13-2019 sections 16.4.1.1, A.16.4.1.1, and 16.4.1.3)
2. Antifreeze systems (NFPA 13-2019 section 16.4.1.2)
3. Heat-tracing systems (NFPA 13-2019 section 16.4.1.4)
4. Heat loss calculations (NFPA 13-2019 16.4.1.5)

Insulated Coverings

Upcoming Technical Tuesdays

November 19, 2019

NFPA 909 Requirements for Cultural Properties

Presented by Mark Hopkins, Vice President of Engineering

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Did You Know??

The NFSA assigns a member of the Engineering Department staff every business day to answer your technical questions. We call this the **Expert of the Day (EOD)** program and it is available to our members by phone, or e-mail. **Call us at (443) 863-4464**, or you can e-mail us at eod@nfsa.org. Last year we answered more than 1400 requests for assistance.

View older issues in the "Member's Only" section

Where large pipes are installed that have sufficient thermal mass, short runs through an unconditioned space may be able to be protected simply with insulated coverings:

> ***A.16.4.1.1*** *Water-filled piping can be run in spaces above heated room, such as attics, even if the space above the room is not heated itself. Insulation can be located above the pipe to trap the heat from below and prevent the pipe from freezing. It is important not to bury the piping in the insulation because if too much insulation ends up between the pipe and the heated space, the insulation will prevent the heat from getting to the pipe. This method of protecting the pipe is acceptable to this standard.*
> ***16.4.1.3*** *Where aboveground water-filled supply pipes, risers, system risers, or feed mains pass through open areas, cold rooms, passageways, or other areas exposed to temperatures below 40°F (4°C), the pipe shall be permitted to be protected against freezing by insulating coverings, frostproof casings, or other means of maintaining a minimum temperature between 40°F and 120°F (4°C and 49°C).*

For smaller pipes that can freeze more quickly additional heat sources may be required. In this case, the additional heat source can be an adjacent conditioned space with insulation tented over the pipe. When installed properly, the use of tented insulation prevents the pipe from freezing by allowing heat transferred from a conditioned space to dominate the heat loss to an unconditioned space, like an attic. NFSA has been developing a white paper on the suggested practices when this method is chosen and should be available early next year. Additionally, a Tech Tuesday on Insulation Practices was presented last June and is available on the NFSA Online Learning platform.

Antifreeze Systems

As permitted in NFPA 13-2019 section 16.4.1.2, NFPA 13 additionally requires all antifreeze solutions to be listed except in the case of premixed propylene glycol used in ESFR systems in Chapter 8: System Types and Requirements:

> ***8.6.2* Antifreeze Solutions.***
> ***8.6.2.1**** *Except as permitted in 8.6.2.2, antifreeze solutions shall be listed for use in sprinkler systems.*
> ***8.6.2.2*** *Premixed antifreeze solutions of propylene glycol shall be permitted to be used with ESFR sprinklers where the ESFR sprinklers are listed for such use in a specific application.*

In addition to conforming with local health regulations, the solutions must also follow The Standard for Antifreeze Solutions for Use in Fire Sprinkler Systems, ANSI/CAN/UL 2901 which has been available through Underwriters Laboratories (UL) since December 19, 2013 as an outline of investigation and has recently passed ballot to become a consensus standard by both ANSI and SCC standards. For more information on the UL listing process and listed antifreezes, check out TechNotes #411 released earlier this year.

The installation requirements for listed solutions are consistent in NFPA 13R and in NFPA 13D. New antifreeze systems are permitted to use 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-2019 section 9.2.2.2*).

Antifreeze System Maintenance

Maintenance of these systems poses an additional challenge. 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 25-2020 section 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.*

NFSA has compiled these references on our ITM page

This Month in Engineering

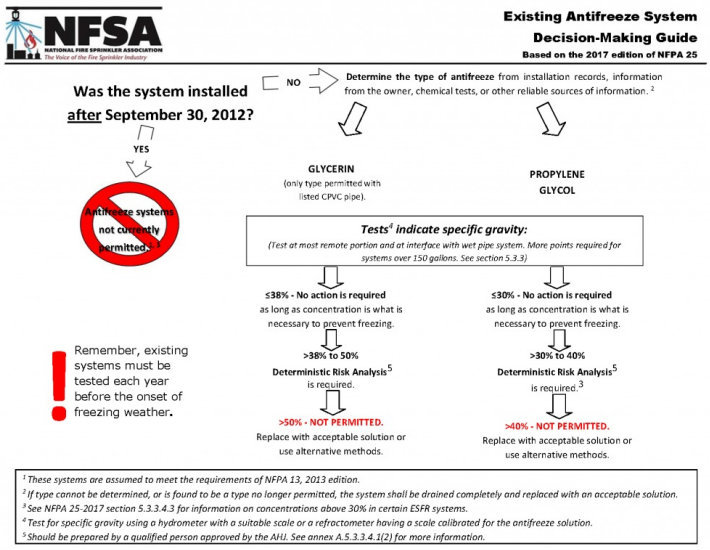
Layout Technician Training:

https://LayoutTechnicianClass

Layout Technician Training - Fundamentals
Online Training
Open for Registration
Jan 1 - Dec 31, 2019

Layout Technician Training - In

and the resources can be accessed using the link on the "Existing Antifreeze Systems Decision-Making Guide" below:



Where jurisdictions are utilizing standards issued in 2007 or earlier, it is still in the best interest of all of the stakeholders to be aware of the current requirements. Although no official amendment has been made by NFPA to the 2007 or prior editions, it would be prudent to consider 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.

Heat-tracing Systems

Like antifreeze solutions, heat-tracing systems are required to be listed:

> ***16.4.1.4*** *Listed heat-tracing systems shall be permitted in accordance with 16.4.1.4.1 and 16.4.1.4.2.*
> ***16.4.1.4.1*** *Where used to protect branch lines, the heat-tracing system shall be specifically listed for use on branch lines.*
> ***16.4.1.4.2*** *Electric supervision of the heat-tracing system shall provide positive confirmation that the circuit is energized.*

After the release of the previous special editions addressing this topic, UL LLC developed the Outline of Investigation for Electrical Resistance Trace Heating and Associated Controls for Use in Sprinkler and Standpipe Systems (UL 515A). With more similarities to antifreeze solutions, this outline of investigation was used as the basis of a listing for the first heat-tracing system for use on sprinkler branch lines. Additional information on this topic can be found in TechNotes

Class Practicum
Baltimore, MD
Jan 20 - Jan 24, 2020

Layout Technician Training - Fundamentals and Practicum
Baltimore, MD
Mar 16 - Mar 27, 2020

Honoring Gayle Pennel

It is with deep sadness that we are sharing the news we've lost a longtime colleague and passionate fire protection engineer, Gayle Pennel, who passed away earlier this week.

Gayle was one of the leading technical experts in the fire protection industry. He has been on several NFPA committees throughout his 40+ year career, including serving as the Chair, and go-to expert, for NFPA 20. Known as "The Encyclopedia" amongst his colleagues, he had a wealth of information on anything related to sprinkler systems and was always available to answer questions.

As dedicated as he was to his profession, he was even more devoted to his family - wife, Diane, a son, Paul, a daughter, Casey, and six grandchildren. He would speak of them often and it was clear they brought him a true sense of joy. Gayle also made a point to get to know more about his colleagues and their own families.

Gayle's passing is a huge loss to his family, colleagues and the fire protection engineering industry. Please keep those who knew him best in your thoughts as they navigate this difficult time.

#418 issued last April.

Installing and Maintaining Antifreeze for 13D

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. 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.

Systems installed in accordance with NFPA 13D do not need to meet NFPA 25 nor the rules discussed above. Instead, NFPA 13D-2019 has its own simplified requirements to deal with antifreeze in existing systems:

> ***9.2.2* Antifreeze Solutions.***
> ***9.2.2.1*** *Except as permitted in 9.2.2.2, antifreeze solutions shall be listed for use in new sprinkler systems.*
> ***9.2.2.1.1*** *For existing systems, antifreeze solutions shall be limited to premixed antifreeze solutions of glycerine (chemically pure or United States Pharmacopoeia 96.5 percent) at a maximum concentration of 50 percent by volume, propylene glycol at a maximum concentration of 40 percent by volume, or other solutions listed specifically for use in fire protection systems.*
> ***9.2.2.2*** *Premixed solutions of glycerine (chemically pure or United States Pharmacopoeia 96.5 percent at a maximum concentration of 48 percent by volume or propylene glycol at a maximum concentration of 38 percent by volume shall be permitted to protect piping that is supplying sprinklers in a specific area of the dwelling unit, where acceptable to the authority having jurisdiction.*
> ***9.2.2.2.1*** *Documentation shall be presented to the AHJ to substantiate the use of the antifreeze solution.*
> ***9.2.2.3*** *The specific gravity of the antifreeze solution shall be checked by a hydrometer with a scale having 0.002 subdivisions.*

Heat Loss Calculations

The last freeze protection remedy does not involve any additional coverings or materials, just an analysis by a professional engineer:

> ***16.4.1.5*** *Water-filled piping shall be permitted to be installed in areas where the temperature is less than 40°F (4°C) when heat loss calculations performed by a professional engineer verify that the*

Upcoming In-Class Seminars

Hydraulics for Fire Protection
Dover, DE
December 11, 2019

Hydraulics for Fire Protection
Conshohocken, PA
December 12, 2019

Design Advantage: Fire Sprinkler Systems and the IBC
Pharr, TX
February 25, 2020

Sprinkler System Plan Review
Tucson, AZ
February 25, 2020

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system will not freeze.

The only freeze protection method where analysis is required is when sprinkler pipe is installed in a space where the ambient temperature is between 32°F and 40°F, but the system is not subject to freezing. All other methods described here within, would not require this in-depth analysis as long as the intent of the standard is followed.

Other Freeze Protection Methods

The next special edition of TechNotes will focus on annual dry pipe maintenance, but in the meantime, these past articles are pertinent as we begin to prepare for the winter months:

"Don't 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)

"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 the cold season is upon us, it is important now to check all of your sprinkler systems and make sure they are ready for winter and adequately protected from the cold. The use of antifreeze in new systems is limited by the parameters of its listing, and even then, some colder climates may require multiple freeze protection methods to maintain the exposed piping at an acceptable temperature. With a variety of freeze protection options, new installations should utilize the most cost effective and efficient method for the project and existing buildings should be inspected and maintained to comply with the requirements of the installation standards prior to the next big freeze.