FIRE PREVENTION ALERT #2010-01

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SUBJECT: Fire Sprinkler Systems Containing Antifreeze Solution

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The Seattle Fire Marshal's Office has received information regarding two explosions and resulting fires which have occurred when sprinkler systems using antifreeze solutions were activated. A report issued by Stephen D. Hart, a consultant for the National Automatic Sprinkler IP-Fund, outlines concerns related to this practice.

NFPA 13 (Standard for the Installation of Sprinkler Systems set by the National Fire Protection Association) requires the use of propylene glycol or glycerin based antifreeze solutions in wet fire sprinkler systems that are connected to a potable water source. In at least two cases, one in October 2001 and another in August 2009, a sprinkler head was activated on a wet sprinkler system containing antifreeze solution and an explosion and fire occurred. In both cases injuries occurred. The August 2009 event resulted in one fatality.

The *Fire and Explosion Investigation Report*, issued September 17, 2009, references NFPA 13, NFPA 25 (Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems) and the manufacturers' specific requirements, recommendations, and physical attributes for the use of these products. It states that several Material Safety Data Sheets (MSDS) for both propylene glycol and glycerin solutions contain the statement "Avoid generation of mist.". In the physical and chemical properties of the *Explosion Properties* section the reader is told that an explosion is "not to be expected."

Further study of the MSDS reveals that both of these chemical solutions burn. The MSDS show that the flashpoint of propylene glycol is 210^{o}F and ethylene glycol is 231^{o}F and that glycerin, depending on the type of test, has a flash point between 320^{o}F and 390^{o}F. Hazardous materials with these flashpoints are defined as Class III-B Combustible Liquids in the Seattle Fire Code Section 3402.1. The NFPA 704 system rates the flammability hazard as "1", which indicates a low fire hazard.

The MSDS [1, 2] for glycol make this statement "Fire Hazards in Presence of Various Substances: Slightly flammable to flammable in presence of open flames and sparks, of heat. [It is] non-flammable in presence of shocks."

The conclusion that can be drawn from this information is that when propylene glycol and glycerin based products are made into a mist (atomized) in the presence of flame it is possible for these products to ignite.

Below is an overview of NFPA 13, NFPA 25, the NFPA Automatic Sprinkler Systems Handbook (NASSH), and NFPA commentary (NCOM) on the subject of antifreeze in sprinkler systems. These sources set standards for best practice and give recommendations and commentary on subjects relating to fire.

NFPA 25 Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems Section 5.3.4 Antifreeze Systems (2002 edition) states: "The freezing point of solution in antifreeze shall be tested annually by measuring the specific gravity with a hydrometer or refractometer and adjusting the solutions if necessary". The NCOM on this section goes on to state: "Listed CPVC sprinkler pipe and fittings should be protected for freezing with glycerin only. The use of diethylene, ethylene, or propylene glycols is specifically prohibited. When inspecting antifreeze systems employing listed CPVC piping, the solution should be verified to be glycerin based."

NFPA 13 Table 7.5.2.2 Antifreeze Solutions to Be Used if Potable Water Is Connected to Sprinklers shows that according to NFPA, the concentration of glycerin can be as high as 70% and propylene glycol can be up to 60%. Since manufacturers warn against spraying a mist of these products, it follows that the higher the concentration of antifreeze the higher the likelihood of some type of fire or explosion when a sprinkler head is activated.

NFPA 13 does not limit the size of antifreeze systems. It does, however, have design requirements for these systems. Section 5.5.3.1 states that all permitted antifreeze solutions are heavier than water. As a result this section requires that, "At the point of contact (interface), the heavier liquid will be below the lighter liquid, preventing diffusion of water into the unheated areas. Figures 7.5.3.1 and 7.5.3.2 illustrate how these interfaces can be setup."

From the maintenance side, the **NFPA 25 2002 Handbook** acknowledges that most antifreeze systems are small, with 40 gallons of solution or less, and are generally a part of a larger wet system. It warns that additional inspection, testing, or maintenance activities may be required to ensure uniform mixtures when large antifreeze systems are used to protect large systems. One example is the installation of a circulating system to keep the antifreeze, glycerin or propylene glycol from settling to the lower parts of the sprinkler system. **NFPA 25 5.3.4.3** requires that systems with a capacity greater than 150 gallons have additional

test points for every 100 gallons. It states that if the test results at any test point indicate an incorrect freeze point in the system, the system shall be drained, the solution adjusted and the system refilled.

Conclusion

It is known that antifreeze played some role in these incidents; however, the exact conditions that existed within the sprinkler systems at the time of the explosions have not been identified. As a result, the Seattle Fire Department Fire Prevention Division encourages those with responsibility for sprinkler systems to pay attention to detail when designing, installing, and particularly when maintaining antifreeze systems. It is equally important to recognize if an antifreeze system was installed incorrectly or contains the wrong type of antifreeze (e.g. using glycol-based products in CPVC pipe). The Seattle Fire Department Fire Prevention Division recommends maintaining current knowledge of antifreeze systems and being alert for updates on their safe operation.

Footnotes

1. http://www.sciencelab.com/xMSDS-Ethylene_glycol-9927167 (Ethylene glycol)
2. http://www.sciencelab.com/xMSDS-Propylene_glycol-9927239 (Propylene glycol)

Citations

Hart, Stephen D. *Fire and Explosion Investigation Report,* 17 September 2009.

NFPA 13 Standard for the Installation of Sprinkler Systems (2002 edition); Chapter 5 Section 5.5.3.1, Chapter 7 Section 7.5.

NFPA 25 Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems (2002 edition). Chapter 5 Section 5.3.4 Antifreeze Systems.

NFPA 25 Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems Handbook (2002 edition). Commentary on Section 5.3.4 Antifreeze Systems.