

Preface

NFPA 13, *Standard for the Installation of Sprinkler Systems*, has included guidance on the use of antifreeze solutions in fire sprinkler systems since the 1940 edition. [1] Antifreeze solutions may be used in fire sprinkler systems where the piping system, or portions of the piping system, may be subject to freezing temperatures. [2] Antifreeze solutions permitted for use in sprinkler systems connected to potable water supplies include propylene glycol and glycerin.

Recent fire incidents, analysis of available literature, and preliminary testing have identified concerns with the use of certain antifreeze solutions. Under certain conditions, solutions of glycerin and propylene glycol antifreeze have been found to ignite when discharged from automatic sprinkler systems. A literature review, preliminary testing, and a long term research plan were developed as part of Phase I of this project. This Report outlines the results of Phase II of the project, which includes further testing of propylene glycol and glycerin antifreeze solutions for a range of concentrations and operating conditions. The testing and analysis were limited to antifreeze solutions discharged through residential sprinklers and did not investigate other types of sprinklers.

A test plan was developed for Phase II to investigate the potential for large-scale ignition of antifreeze solutions discharged from residential sprinklers and the influence of antifreeze solutions on the effectiveness of residential sprinkler systems in controlling a fire condition and maintaining tenable conditions for egress. Testing was conducted in two parts. Scope A consisted of fire tests using six (6) models of sprinklers at elevations of 8 ft and 20 ft to investigate the potential for large-scale ignition of antifreeze sprays at pressures ranging from 10 psi to 150 psi. Scope B consisted of room fire tests, similar to UL 1626, that were designed to investigate the effective of sprinklers discharging antifreeze solutions and their ability to maintain tenable conditions.

Results of the Scope A testing indicate that concentrations of propylene glycol exceeding 40% by volume and concentrations of glycerin exceeding 50% by volume have the potential to ignite when discharged through residential sprinklers. The potential for ignition depends on several factors including the ignition source, sprinkler model, sprinkler elevation, discharge pressure, and the location of the sprinkler

with respect to the ignition source. Ignition of antifreeze spray increased the measured heat release rate in certain tests with 50% propylene glycol and 55% glycerin by more than 300%. For certain test conditions, the increase in heat release rate resulting from the application of 55% glycerin solution exceeded the increase in heat release rate from the application of 50% glycerin solution by a factor of 10. A similar level of sensitivity was observed between 40% and 50% propylene glycol solutions, but not between 40% and 45% propylene glycol solutions.

The results of the Scope B testing indicated that concentrations of propylene glycol not exceeding 40% by volume and concentrations of glycerin not exceeding 50% by volume have similar performance to water as compared to the UL 1626 fire control criteria. Both the 40% propylene glycol and 50% glycerin solutions met the UL 1626 fire control criteria and demonstrated similar performance to that of water alone throughout the series of tests.

The results of this research suggest that antifreeze solutions of propylene glycol exceeding 40% and glycerin exceeding 50% by volume are not appropriate for use in home fire sprinkler systems. Consideration should be given to an appropriate safety factor for concentrations of these antifreeze solutions that are permitted by future editions of NFPA 13, as well as warnings and limitations outlined in antifreeze product literature.

Based on the flammability properties outlined in Table 4, the use of solutions of diethylene glycol and ethylene glycol in home fire sprinkler systems should also be limited unless testing is conducted to establish that they are appropriate for use in home fire sprinkler systems. The results of this analysis are limited to residential sprinklers; the flammability of antifreeze solutions discharged through other types of sprinklers has not been investigated.

Recommendations are provided for further research in the following areas:

- Investigate the use of Antifreeze Solutions in Sprinkler Systems with Non-Residential Sprinklers
- Characterize Droplet Size Distributions from Sprinklers
- Develop a Small or Medium Scale Screening Test of Antifreeze Solutions
- Develop a Listing Standard for Solutions introduced into Sprinkler Systems

This report is the second in a series of research reports published by the Foundation reporting on research on this topic.