

VII Summary

A test plan was developed for Phase II to investigate the potential for large-scale ignition of antifreeze solutions discharged from residential sprinklers. This test plan also explored 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 and B). Scope A consisted of fire tests using six (6) models of sprinklers operating at pressures of 10 psi to 150 psi at elevations of eight and twenty feet. The Scope A testing was intended 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 effectiveness of sprinklers discharging antifreeze solutions and their ability to maintain tenable conditions.

Results of the Scope A testing indicated 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 automatic 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. Tests with the 40% propylene glycol and 50% glycerin solution met the UL 1626 fire control criteria and demonstrated similar performance to water throughout many of the 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 antifreeze solutions that are permitted by future editions of NFPA 13, as well as warnings and limitations outlined in antifreeze product literature. In addition, 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.

Recommendations for further research are also provided. Further research should be conducted to investigate the use of antifreeze solutions supplied through non-residential sprinklers. The results of this study are based on tests with residential sprinklers, which are not directly applicable to other types of sprinklers due to the unique spray pattern of residential sprinklers. However, the results documented in this report are sufficient to indicate that the use of antifreeze solutions with non-residential sprinklers should also be investigated.

The droplet size distributions produced by sprinklers is an ongoing area of research that is important to understanding the potential for ignition of antifreeze sprays. Further development is needed to characterize the droplet size distributions produced by a variety of sprinklers.

The development or investigation of a small or medium scale test for ignition of antifreeze sprays may contribute to understanding the droplet size distributions of antifreeze that have the potential to ignite. Finally, the results of this research indicate that certain concentrations of glycerin and propylene glycol antifreeze solutions are not appropriate for use in residential sprinkler systems. Thus, there is a need for alternative antifreeze solutions that are not currently permitted by NFPA 13. A listing standard for antifreeze solutions or other solutions that are introduced into sprinkler systems could encourage the development of alternative antifreeze solutions and help ensure that the solutions are appropriate for use in sprinkler systems.