



RESEARCH FOUNDATION

RESEARCH FOR THE NFPA MISSION

PROJECT SUMMARY

Protection of Storage Under Sloped Ceilings – Phase 3

4 October 2018

Background: There is limited prior research related to protection of storage under ceilings with slopes steeper than 2/12. Previous studies exist from FM Global, University of Maryland/Custom Spray Solutions, the Fire Protection Research Foundation, and National Fire Sprinkler Association (NFSA), but there are still many open questions related to the protection criteria for storage under sloped ceilings. The questions include, but not limited to, sprinkler activation pattern relative to fire source location, and optimal sprinkler installation orientation.

There are many different parameters related to this design challenge. Some of the key parameters include the slope of the ceiling, the commodity being stored, types of sprinklers (including ESFRs), sprinkler orientation, and sprinkler spacing. Some possible protection design solutions to sloped ceiling facilities are to use higher densities or larger calculation areas than for storage under flat ceilings.

[Previous modeling efforts](#) have identified some of the potential protection challenges related to sloped ceilings and have led to the development of a full scale test plan, which will be undertaken during this phase of work.

Research Goal: The overall goal of the project is to determine the impact of sloped ceilings on protection of storage and develop the technical basis for the NFPA 13 Technical Committees for new requirements and guidance. The objective of this Phase 2 project is to build on the Phase 1 simulations with additional variables and to develop a full scale test plan for future work.

Project Tasks:

Task 1 – Sprinkler Characterization Testing: This task is to conduct a series of laboratory tests to gather additional data on the impact of sprinkler orientation, ceiling slope, and standoff distance.

- A. Spray characterization testing to provide details of the drop size and flux for elevation and azimuthal angles. This testing will also consider sprinkler/ceiling impingement effects
- B. Demonstrative testing to be performed under a sloped ceiling to capture flow fluxes and visual images of the spray.

Task 2 – Full-Scale Test Plan: Based on the [test matrix developed in Phase 2](#), develop a test plan for full-scale fire testing to study the impact of the sloped ceiling on sprinkler performance. The goal of the testing will be to develop protection recommendations for storage under sloped ceilings.

Task 3 - Full-Scale Testing: Implement the test plan developed in Task 2 and develop a test report with results.

Task 4 – Final Report: Develop a final summary report that contains the results from the Task 1 testing as well as summarize the full scale testing completed in Task 3. Report will include guidance and recommendations for sprinkler protection of storage under sloped ceilings.

Implementation: This research program will be conducted under the auspices of the Research Foundation in accordance with Foundation Policies and will be guided by a Project Technical Panel who will provide input to the project, recommend contractor selection, review periodic reports of progress and research results, and review the final project report.

Reporting and Deliverables: A full-scale fire testing report, a draft final summary report, and a final summary report will be developed for this project. The Research Foundation will retain rights to the final summary report, which will be published on the Foundation website. Final results will be presented to the NFPA 13 Technical Committees on Sprinkler System Discharge Criteria and Installation Criteria or at another appropriate venue.

Schedule: The final report will be available June 2019.