RESEARCH FOUNDATION

RESEARCH FOR THE NFPA MISSION

PROJECT SUMMARY

Protection of Storage Under Sloped Ceilings – Phase 2

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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.

Further modeling analysis will be beneficial in order to understand the potential protection challenges related to sloped ceilings, and to determine the range of scenarios that should be studied further through testing. The information from this work as well as information gathered from testing could help inform the NFPA 13 requirements.

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 - Case Specification: Cases will be specified considering five design element focus areas, which include 1) Ceiling Configuration Dimensions (e.g. slope); 2) Ceiling Configuration Construction Details (e.g. ridges, purlins); 3) Sprinkler Spray Pattern; 4) Sprinkler Orientation; and 5) Sprinkler Standoff Distance.

Task 2 - Simulations: The simulation task will consist of (a) supporting laboratory tests to establish appropriate input specifications for these simulations and (b) computational activities.

(a) Conduct two series of laboratory tests to support the simulations: (i) develop additional spray pattern characterizations and (ii) evaluate the sprinkler/ceiling impingement effects.

i) Spray pattern representations of the sprinklers that will be used in simulations (and under consideration for full-scale tests) will be obtained through detailed initial near-field spray measurements.

ii) Tests to evaluate sprinkler/ceiling impingement effects (e.g. considering sprinkler spray pattern, orientation, standoff-distance, slope) on density will support model treatment and validation.

(b) FireFOAM simulations will be conducted to evaluate suppression performance in terms of activation, delivery or combined activation and delivery problems similar to the approach used for Phase 1. Simulations will explore the impact of additional sprinkler types, ceiling slope, sprinkler orientation, impact of structural obstructions such as purlins and girders, impact of roof ridges, and sprinkler standoff distance.

Task 3 - Full-Scale Test Matrix: Evaluate the simulations and define full-scale test conditions for future work. Develop a final report that includes testing recommendations. The final report will contain the Task 1 work, a summary of the Task 2 work, and the Task 3 recommendations for full-scale tests.

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: An interim case specification, a draft simulation report, a final simulation report, a draft final report and a final report will be developed for this project. The Research Foundation will retain rights to the final 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 July 2017.