



# RESEARCH FOUNDATION

RESEARCH FOR THE NFPA MISSION

## Protection of Storage Under Sloped Ceilings Phase III: Large Scale Testing

There is limited prior research related to protection of storage under ceilings with slopes steeper than 2/12 and there were open questions on 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](#) identified some of the potential protection challenges related to sloped ceilings and developed a plan for full scale testing.

### **Project Goal & Approach**

During this phase of the project, the previously developed full-scale test plan was implemented with the goal to determine the impact of sloped ceilings on protection of storage and develop the technical basis for new requirements and guidance in NFPA 13.

The final report provides a summary of the results from the full-scale testing along with protection recommendations and is available [here](#).

### **Summary Observations**

The results of this research program provides new information pertaining to the effect of sloped ceilings and sprinkler installation orientations on suppression performance. The observations and conclusions yield the following guidance:

1. Sprinkler deflector orientation should be arranged parallel to the floor to avoid a significant reduction in the water flux available to the ignition region.
2. When sprinklers are to be installed below the bottoms of the ceiling structural support members, such as purlins, the sprinkler deflector should be oriented with the deflectors on a horizontal plane no more than 150 mm (6 in.) below the underside of the structural support member. For ceiling inclinations up to 10°, purlin depths should be limited to 450 mm (18 in.). For ceiling inclinations between 10° and 18° purlin depths should be limited to 300 mm (12 in.).
3. For (1) ceiling slopes up to 10° with purlin depths greater than 300 mm (12 in.), or (2) ceiling slopes over 10° purlin channels should be closed at the girder to prevent excessive ceiling jet channeling.
4. For slopes in excess of 18°, and for all purlin depths, the installation of sprinklers at their normal listed spacing on a horizontal plane below the structural support members is not recommended.
5. Alternative sprinkler spacing options should ensure that there is no obstruction to the discharge pattern from the obstructed ceiling construction, when present.

### **Research by:**



### **Sponsored by:**

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