

Effects of Smoke Vents on Sprinkler Performance – Investigation Through Large-Scale Testing and CFD Modeling

Fire Sprinkler International

June 2023

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RESILIENCE IS A CHOICE.

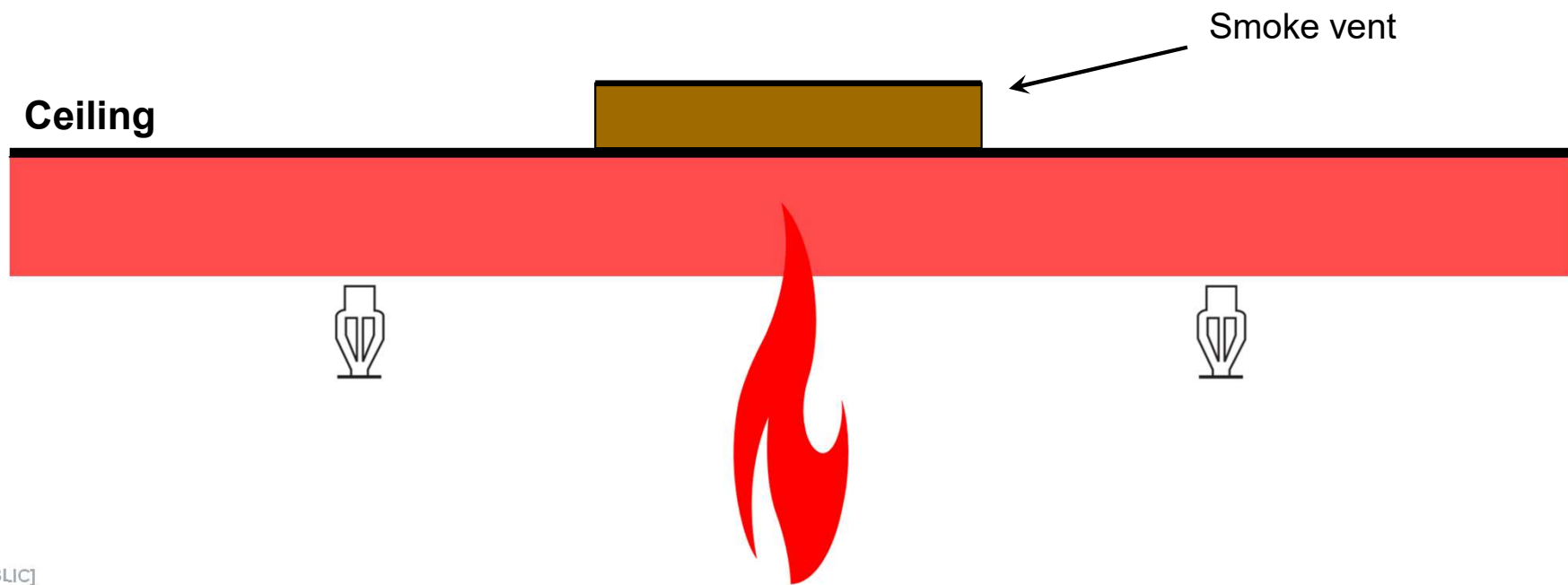
Concerns with Smoke Vents?

Are ESFR sprinklers allowed on dry systems? **NO!**

Why?

Delay of water discharge to the fire area

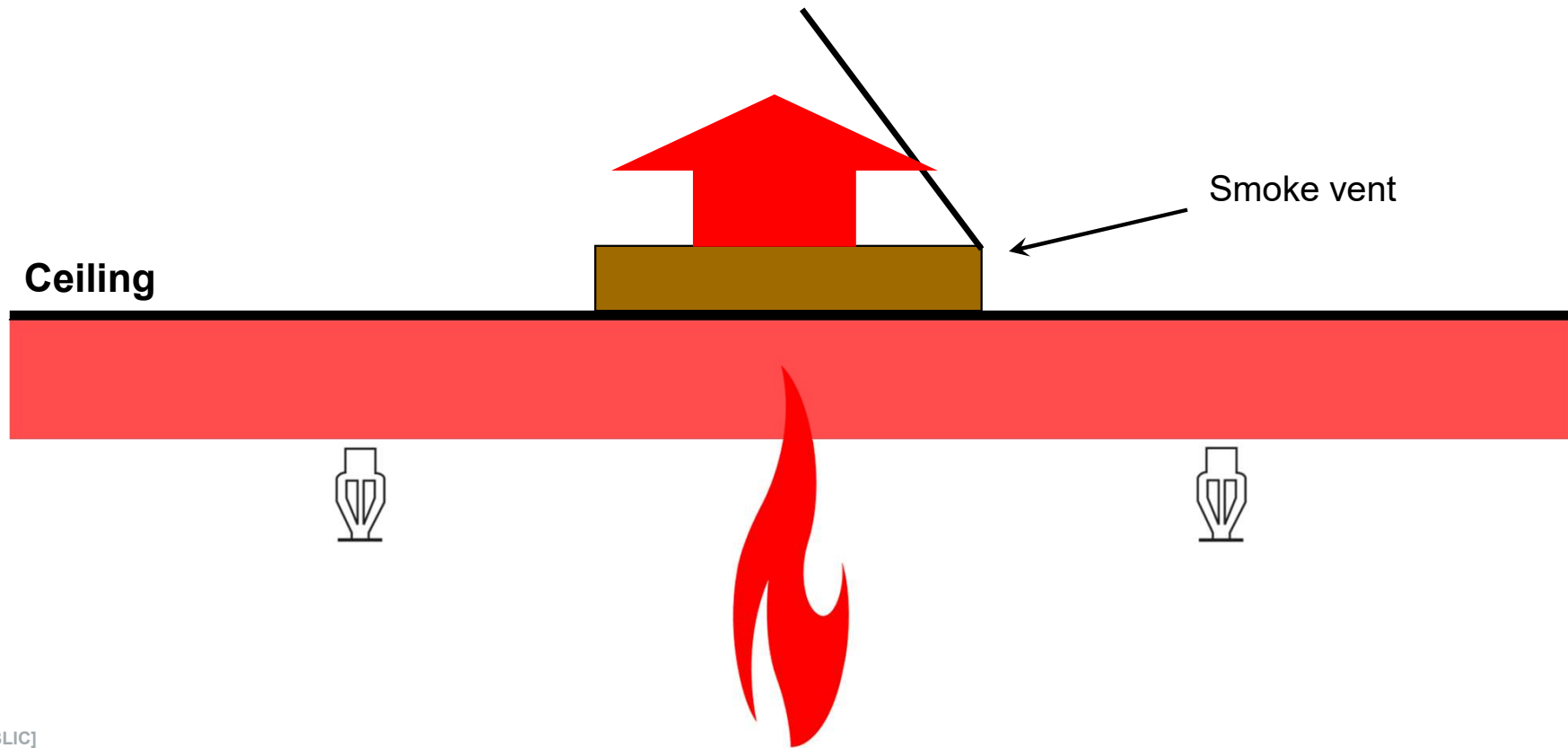
Concerns with Smoke Vents?



Smoke Vents – Effect on Sprinkler Performance



Concerns with Smoke Vents?

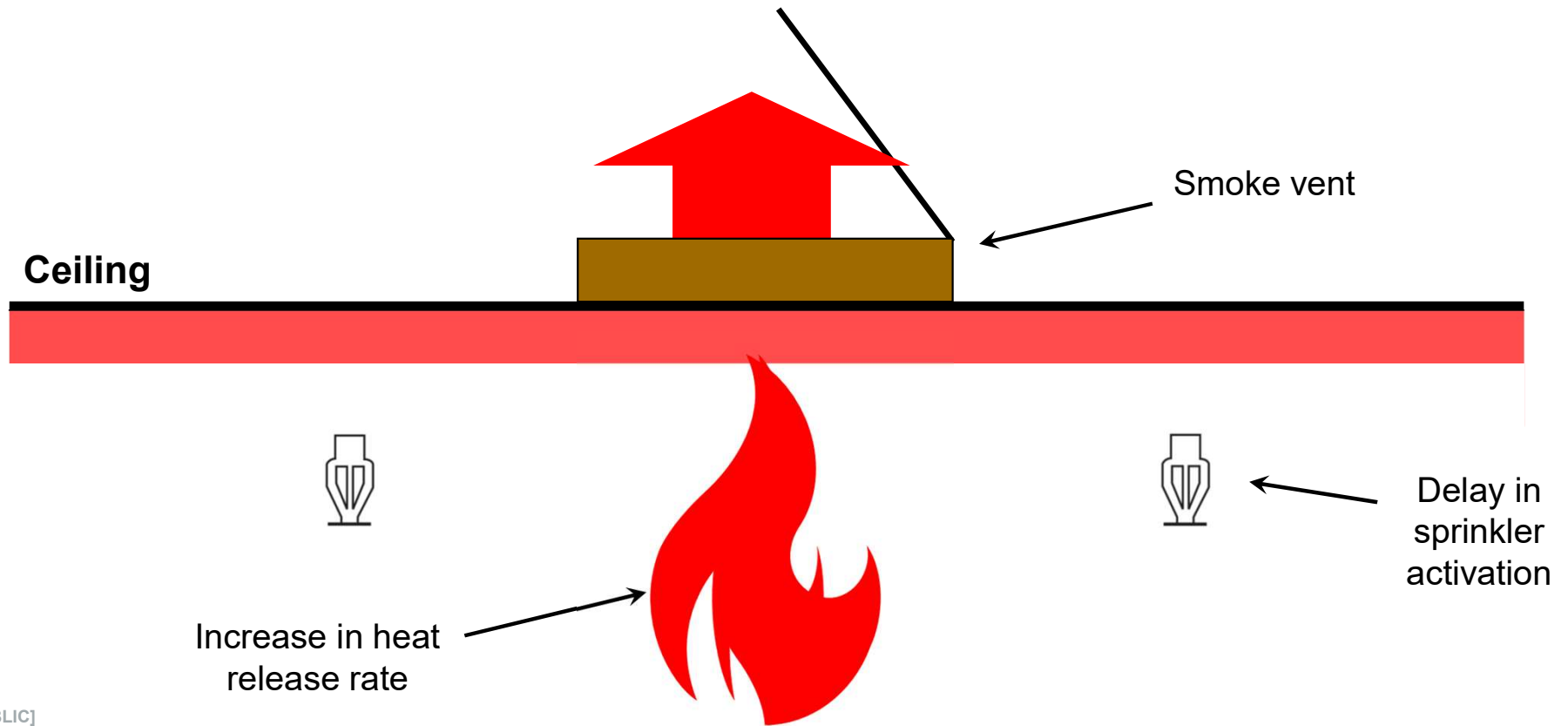


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Smoke Vents – Effect on Sprinkler Performance



Concerns with Smoke Vents?



Current Recommendations in Data Sheet 2-0:

Do not install smoke vents where sprinklers are provided

Various agencies have indicated that the smoke vents are essential for manual extinguishment operations

If smoke vents required by code:

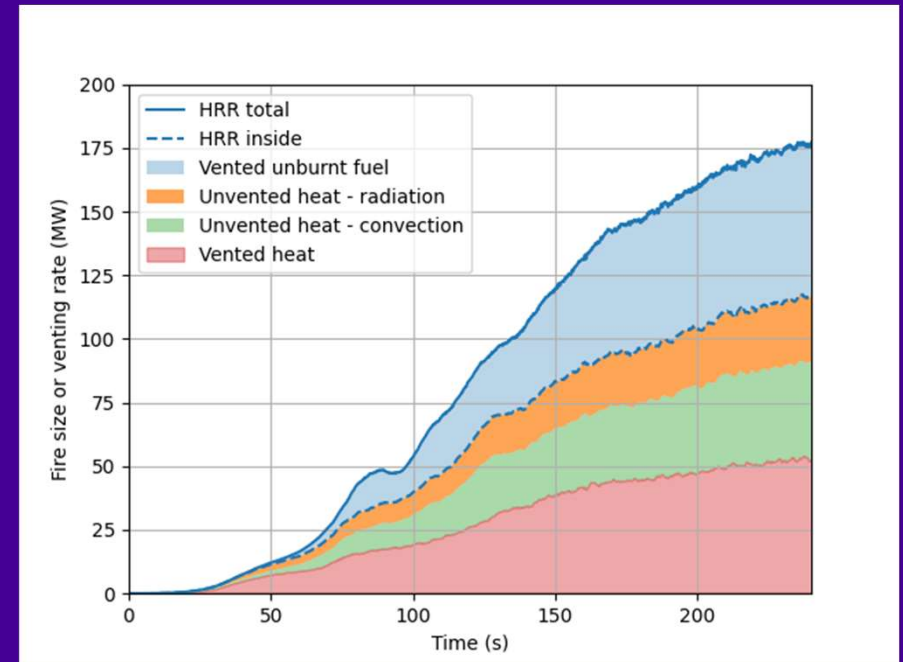
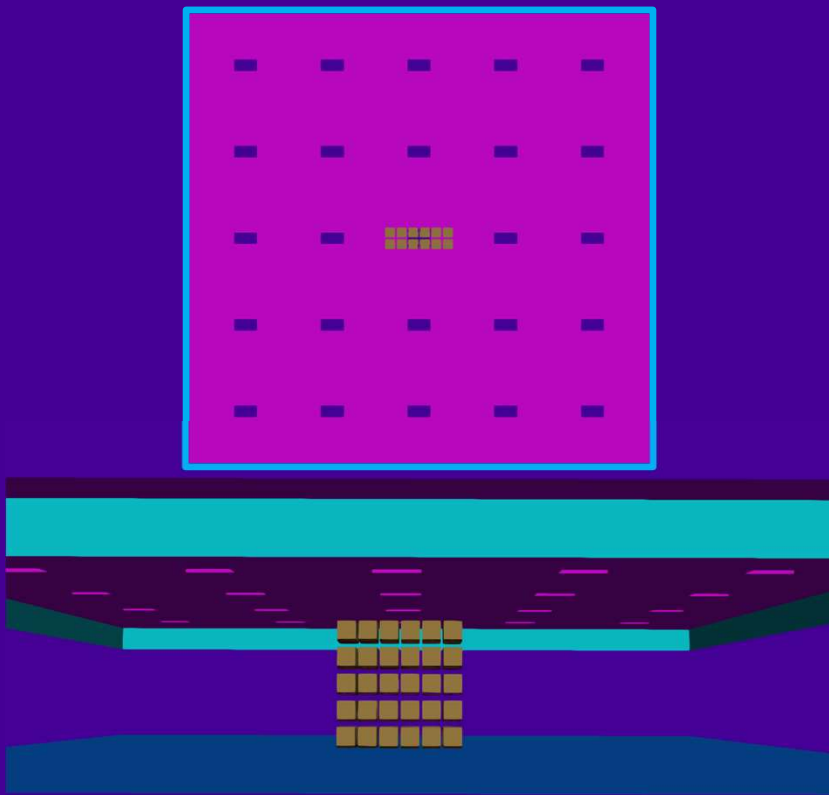
- Install vents equipped with standard-response 180°C (356°F) rated link
- Arrange vents to open upon waterflow alarm with 20-minute delay
- Install supplemental ceiling sprinklers directly underneath vents

Current Recommendations in Data Sheet 2-0:

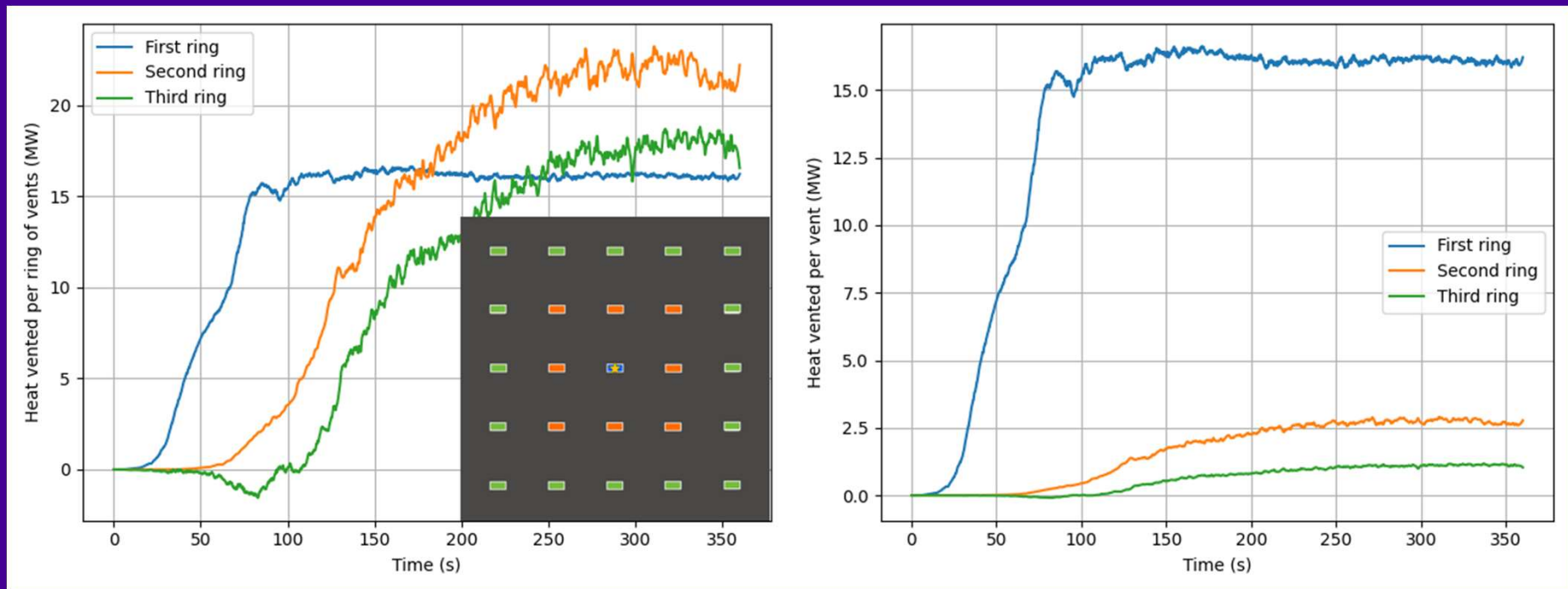
During a fire, will a heat / smoke vent operate prior to a ceiling sprinkler?

If so, can its operation compromise the ceiling sprinkler system's ability to protect the warehouse?

Smoke Vents in Unsprinklered Storage Occupancies



Efficacy of Smoke Vents vs Distance from Ignition



Risk Analysis – Background

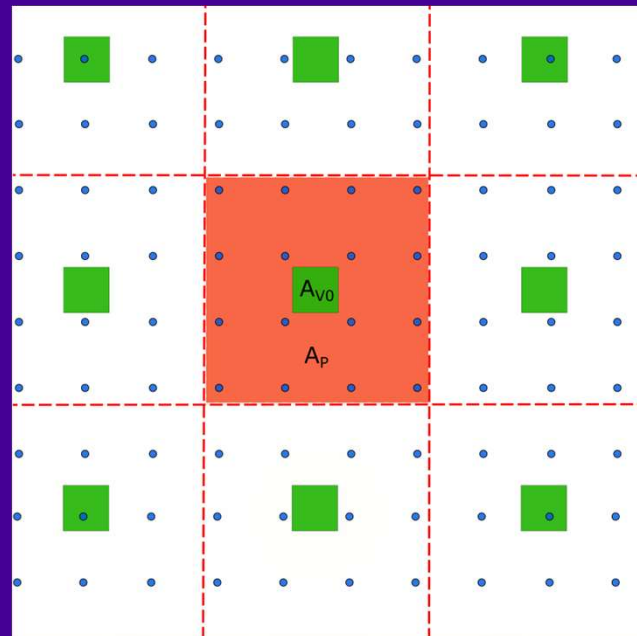


- Risk has two components, probability (likelihood) and impact
- Key questions:
 - What is the likelihood of smoke vents adversely impacting sprinkler protection?
 - What is the impact of smoke vents adversely impacting sprinkler protection
- Sprinkler/vent activation order used as proxy for vent ‘impacting’ sprinkler

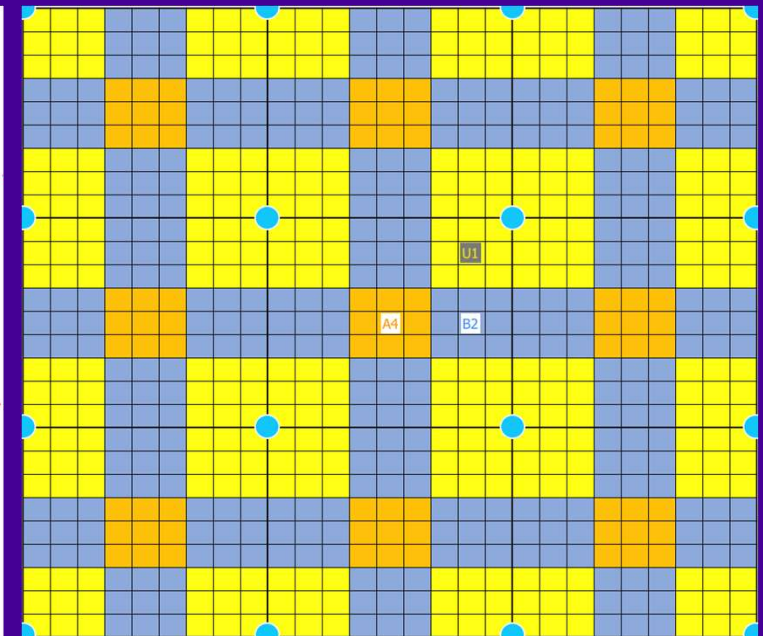
Probabilistic Analysis

Probability of Smoke Vents Opening Before Sprinklers

Array of vents and sprinklers



Weighting factors: $w_{U1} = \frac{4}{9}$, $w_{B2} = \frac{4}{9}$, $w_{A4} = \frac{1}{9}$

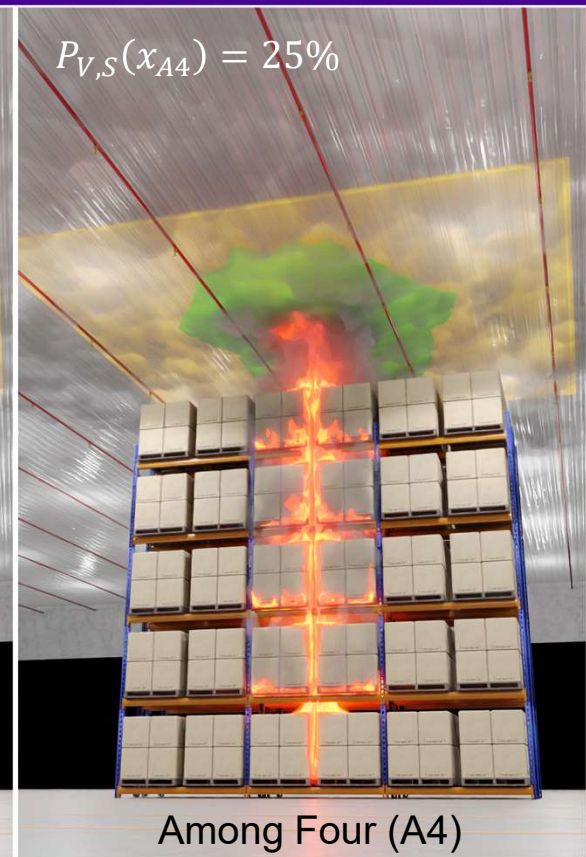
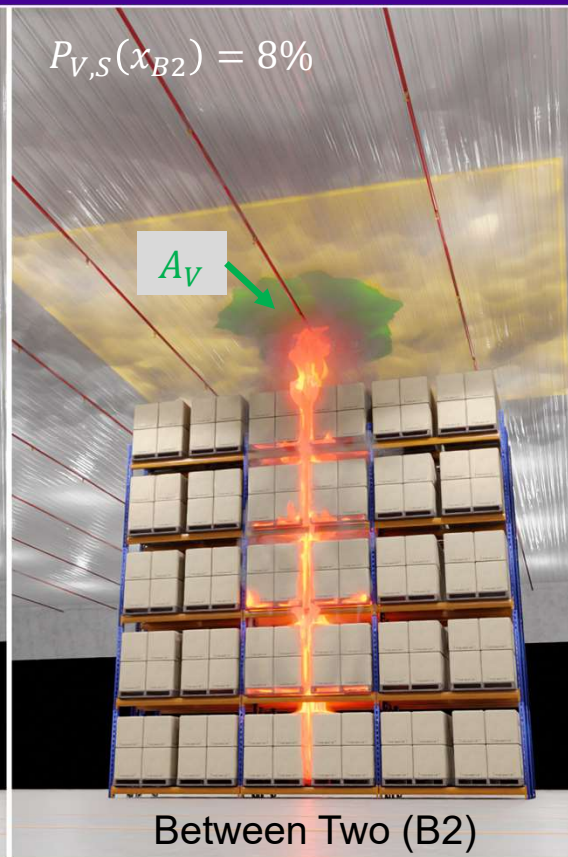


Assuming:

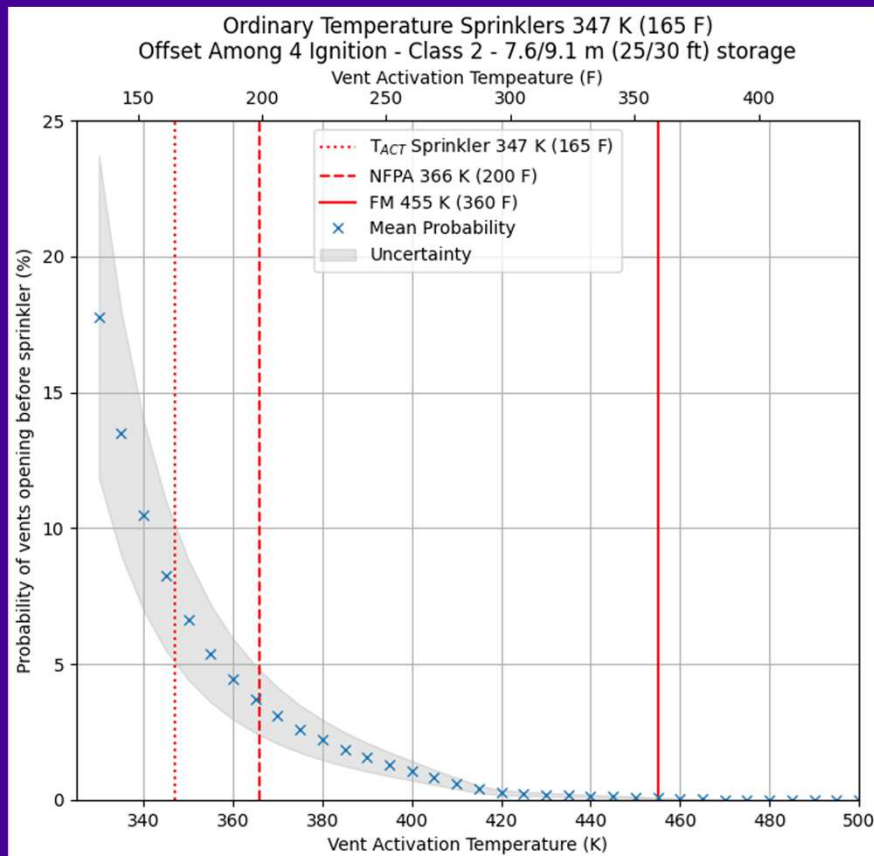
- Uniform spaced sprinkler and vent array
- Independence of vent and sprinkler locations
- Random ignition location “ x_R ”

$$P_{V,S}(x_R) = w_{U1}P_{V,S}(x_{U1}) + w_{B2}P_{V,S}(x_{B2}) + w_{A4}P_{V,S}(x_{A4})$$

Probability Calculation



Results

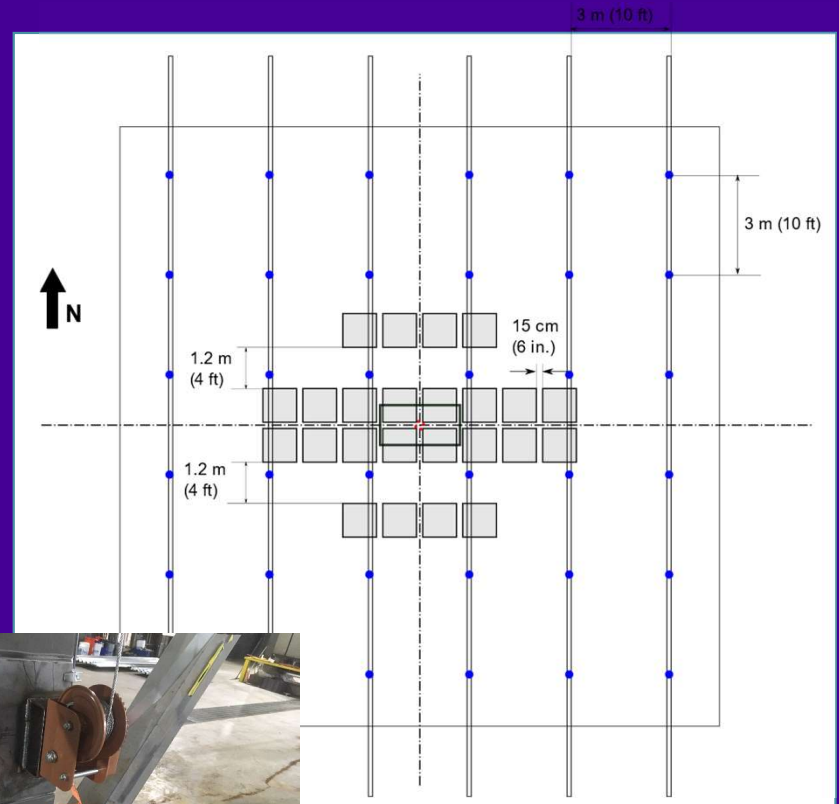
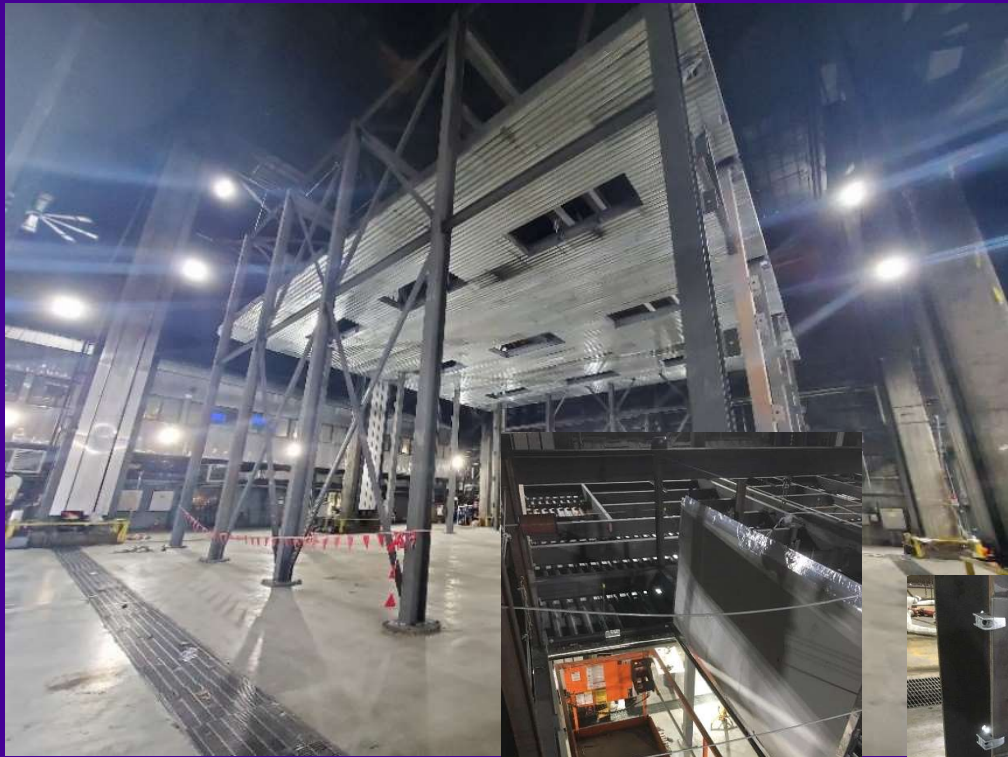


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- Likelihood is low, but non-negligible (<5%)
- Likelihood increases:
 - Gradually with increasing number of vents
 - Rapidly if vent T_{ACT} is less than sprinkler T_{ACT}
- Worst-case ignition scenario
 - Vent directly above ignition location
 - Sprinklers as far as possible from ignition location

Impact Analysis (Worst Case Scenario)

Test Configuration



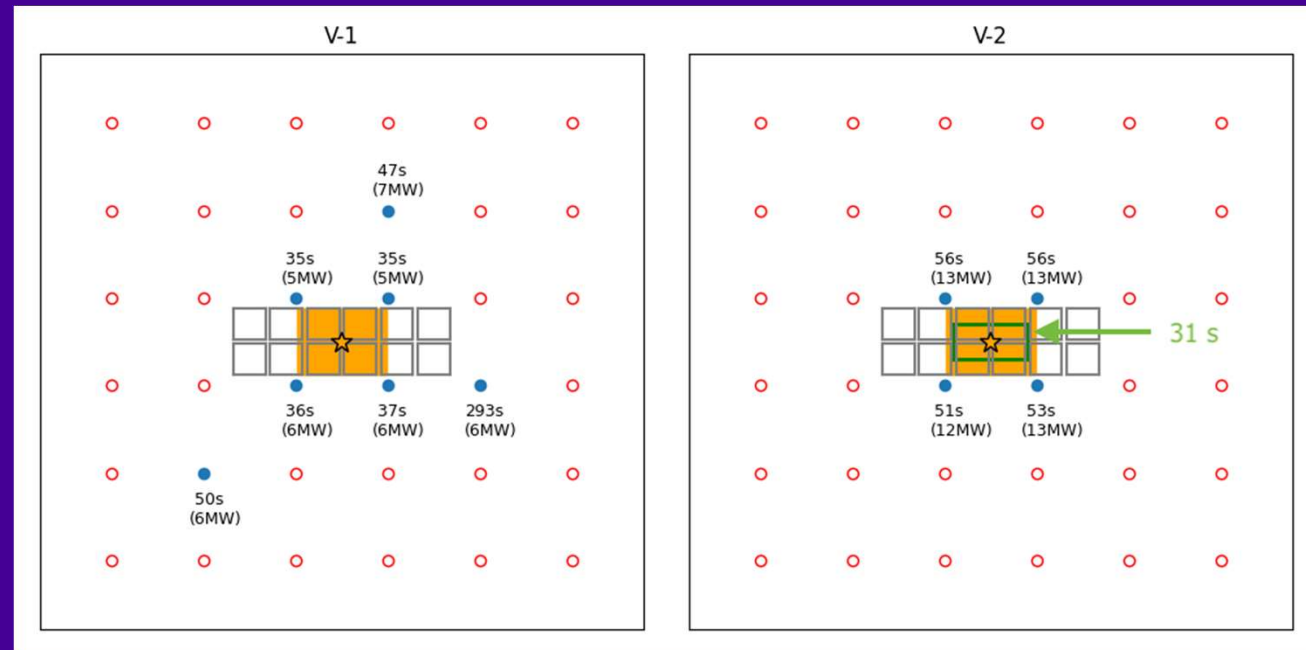
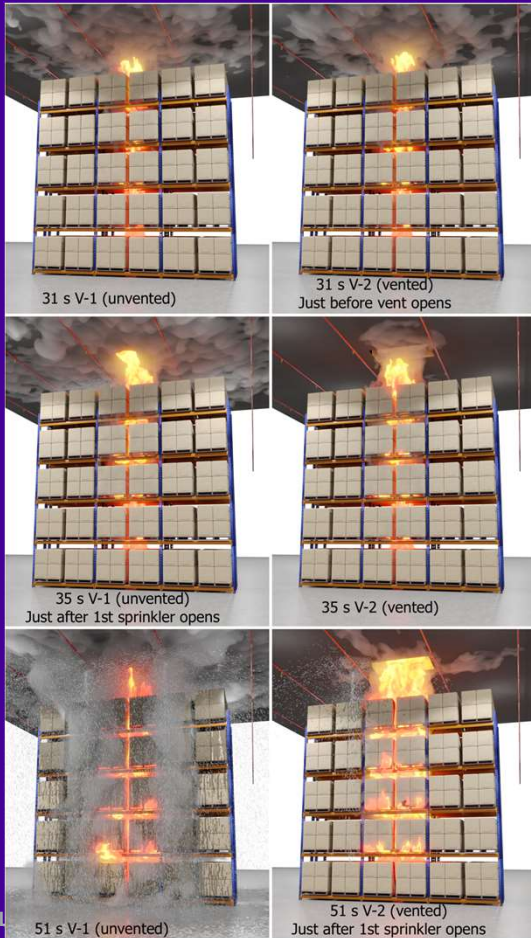
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Test Case 1



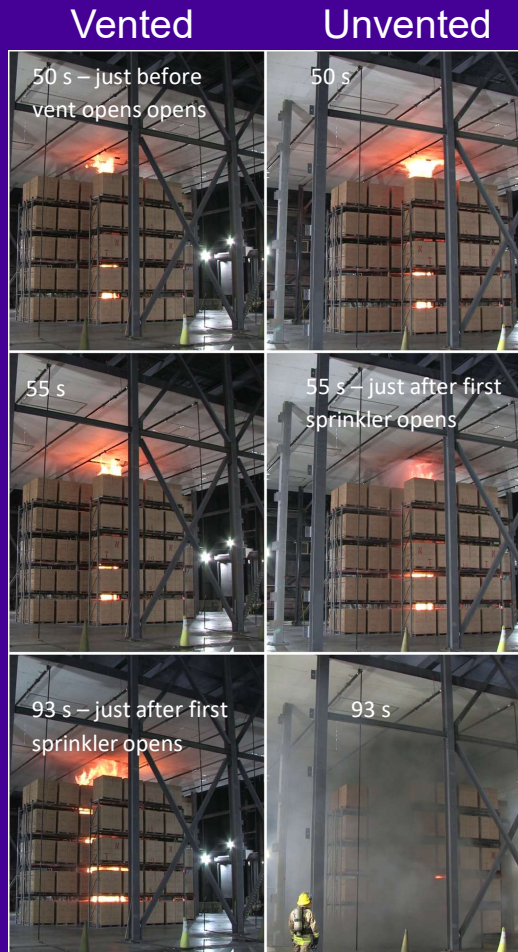
- **Cartoned Unexpanded Plastic (CUP)**
- **7.6 m (25 ft) storage under 9.1 m (30 ft) ceiling**
- **K240 (K16.8) @ 2.4 bar (35 psi)**
- **Protection in FM Global DS 8-9**

Model Results



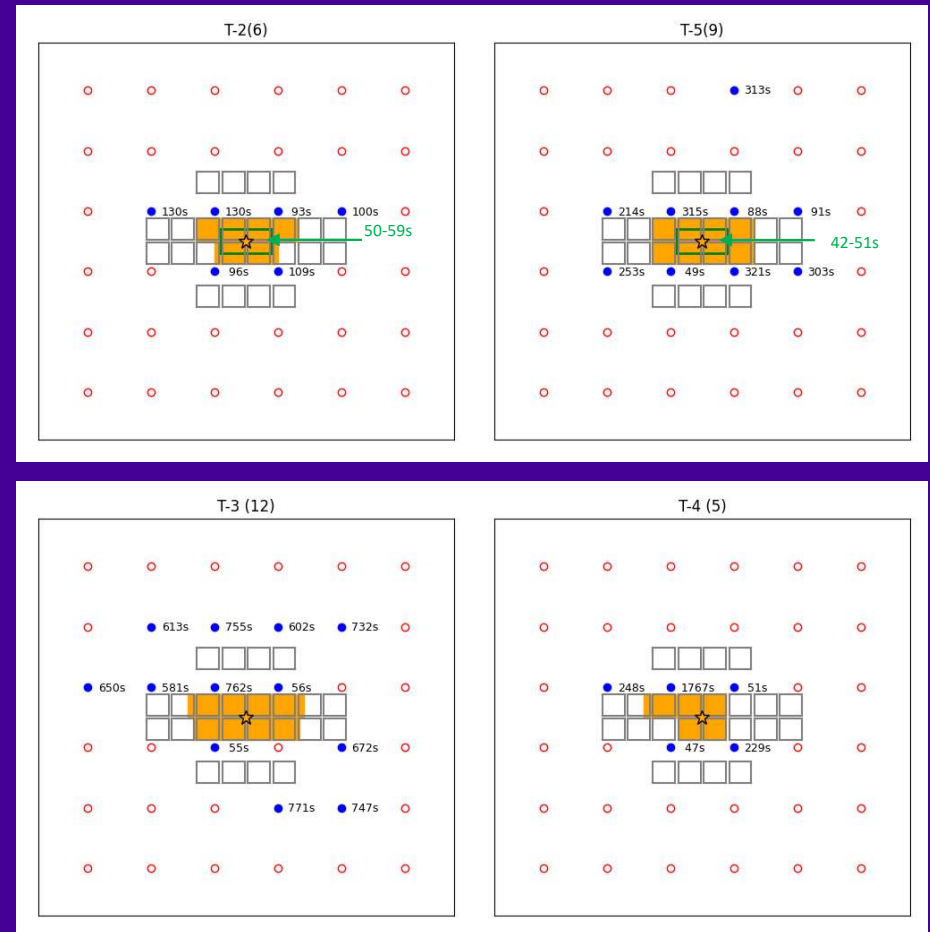
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Results at Recommended Protection Level



Vented

Unvented

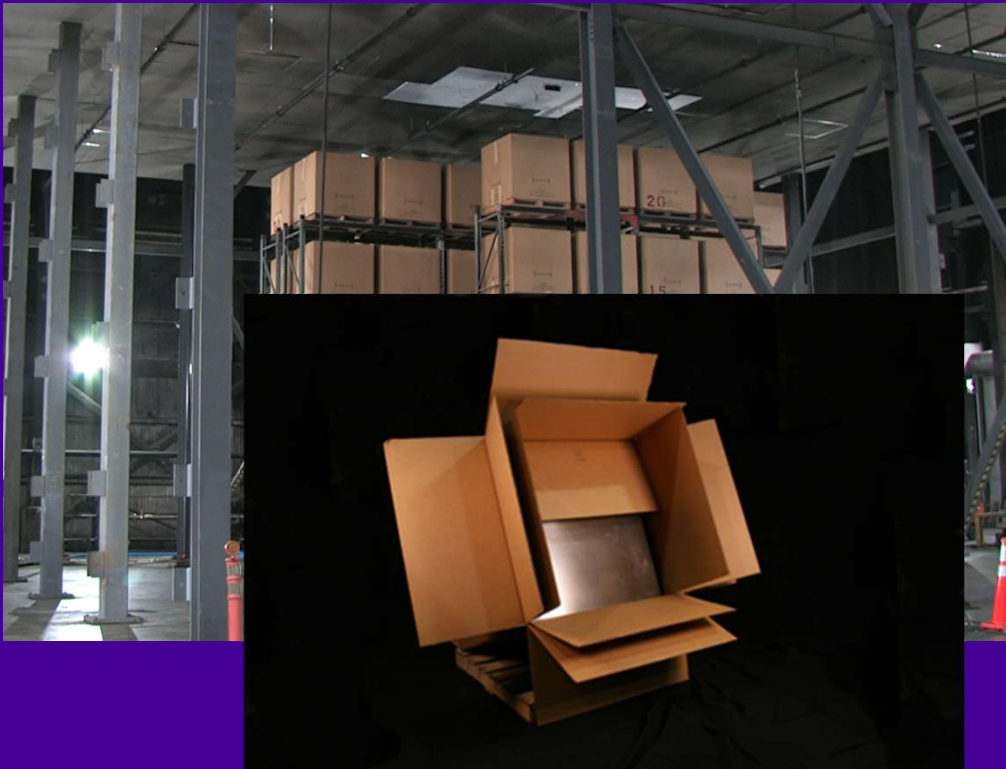


Test Video – Vented vs. Unvented



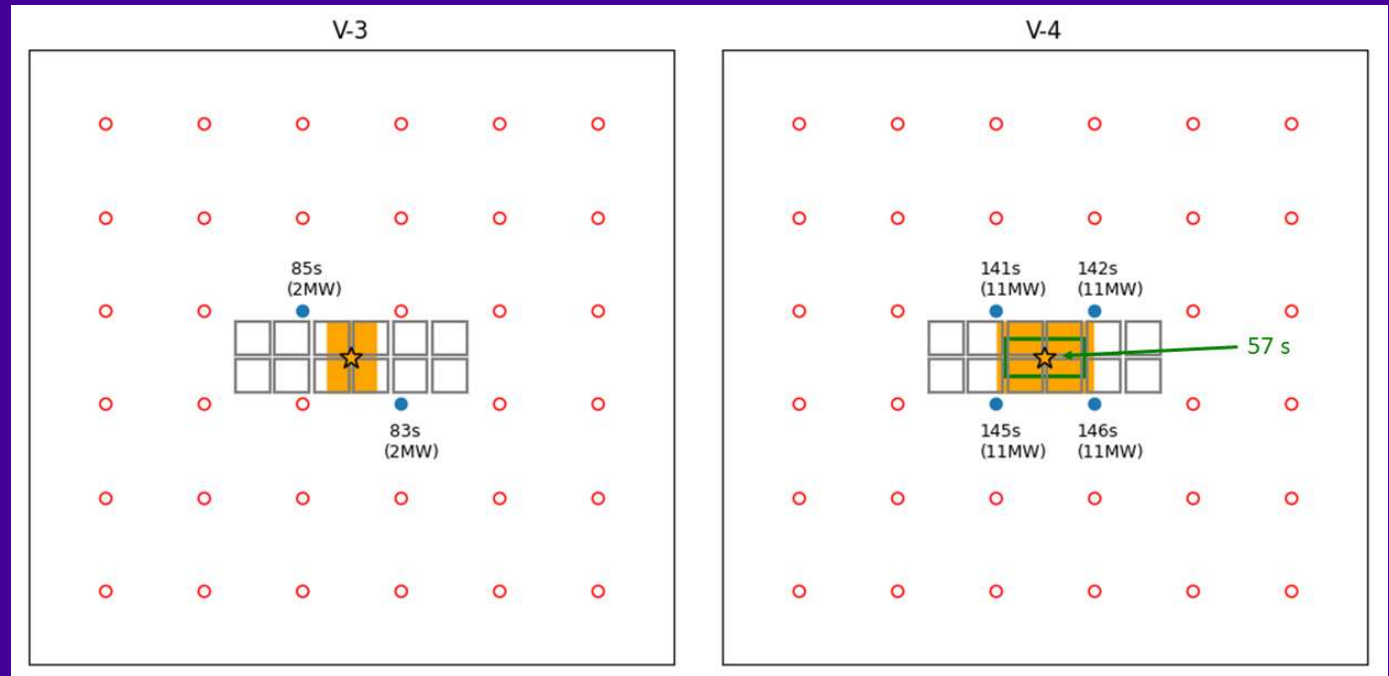
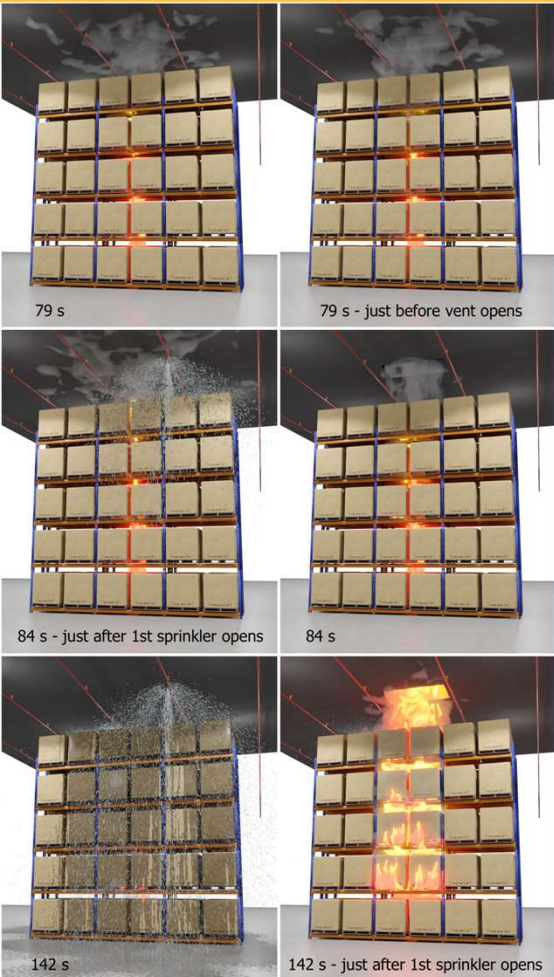
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Test Case 2

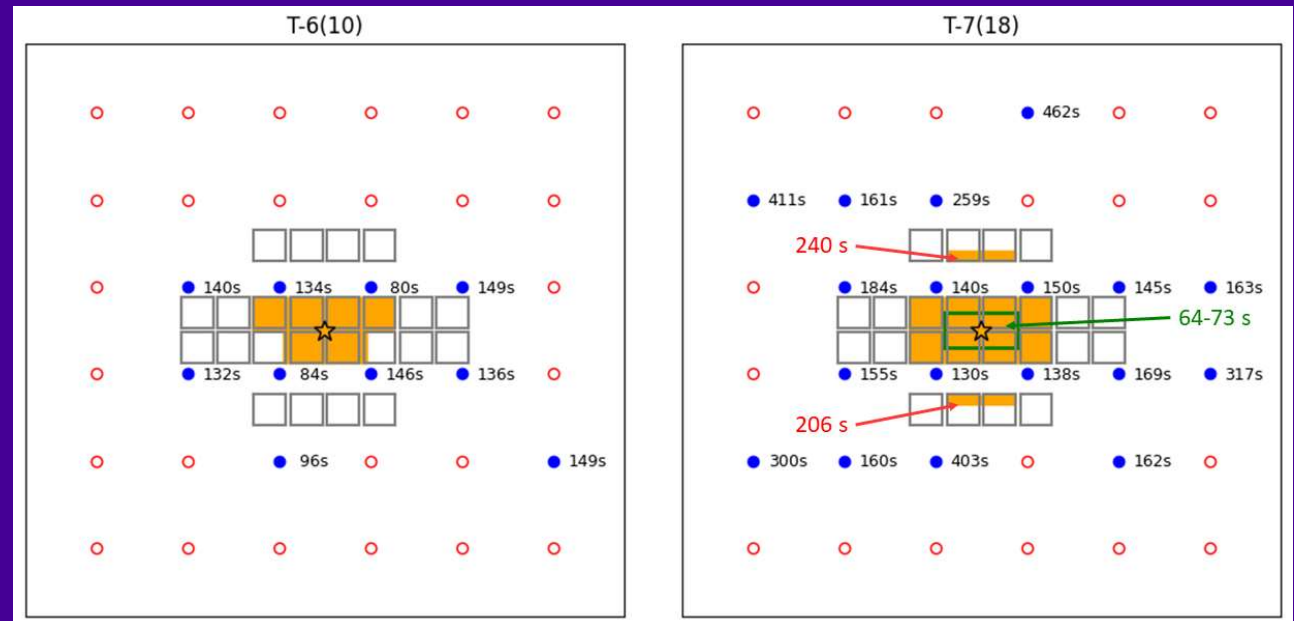
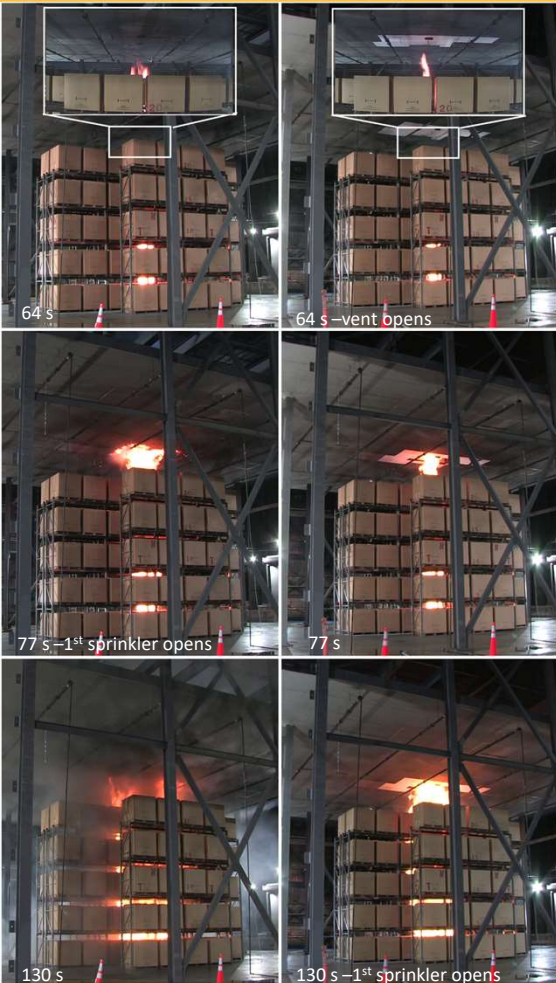


- **Class 2 commodity**
- **7.6 m (25 ft) storage under 9.1 m (30 ft) ceiling**
- **K160 (K11.2) @ 1.7 bar (25 psi)**
- **Protection not in FM Global DS 8-9 but in NFPA 13**

Model Results



Test Results at Marginal Protection Level



Conclusions



- **Smoke vents do not provide any property loss prevention benefit in unsprinklered buildings**
- **For worst case ignition scenario:**
 - **Smoke vents can activate before sprinklers and delay sprinkler activation**
- **For otherwise adequate sprinkler protection:**
 - **Smoke vents did not lead to adverse impact**
- **For marginal sprinkler protection:**
 - **Smoke vents can lead to excessive number of sprinkler operations**

Thank You



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Thank you. Any questions?

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