

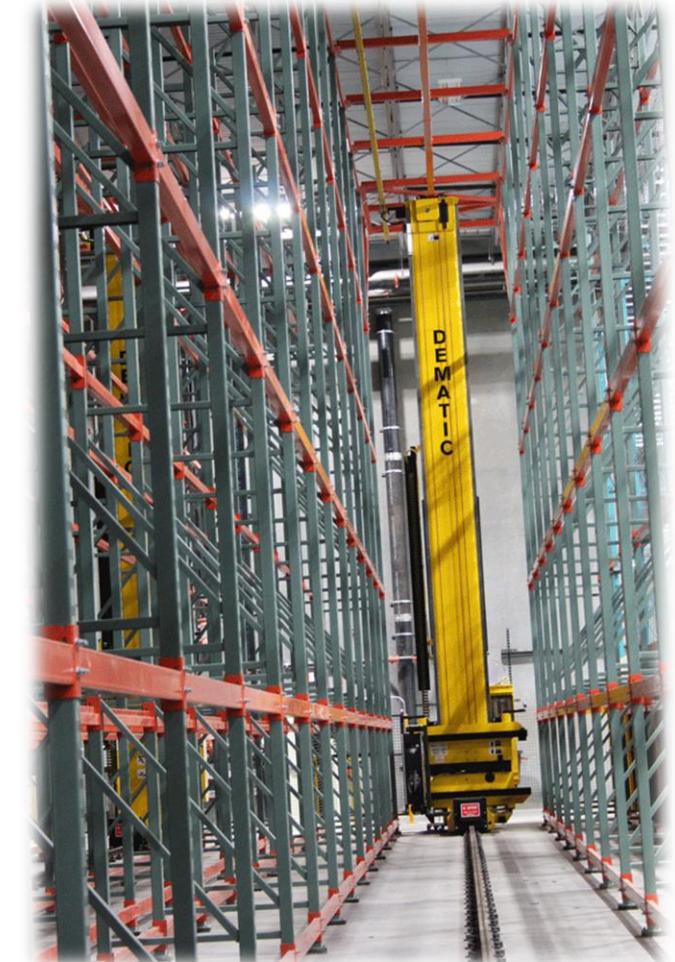
Research – pushing boundaries

Safety Expo - Bergamo – September 2019

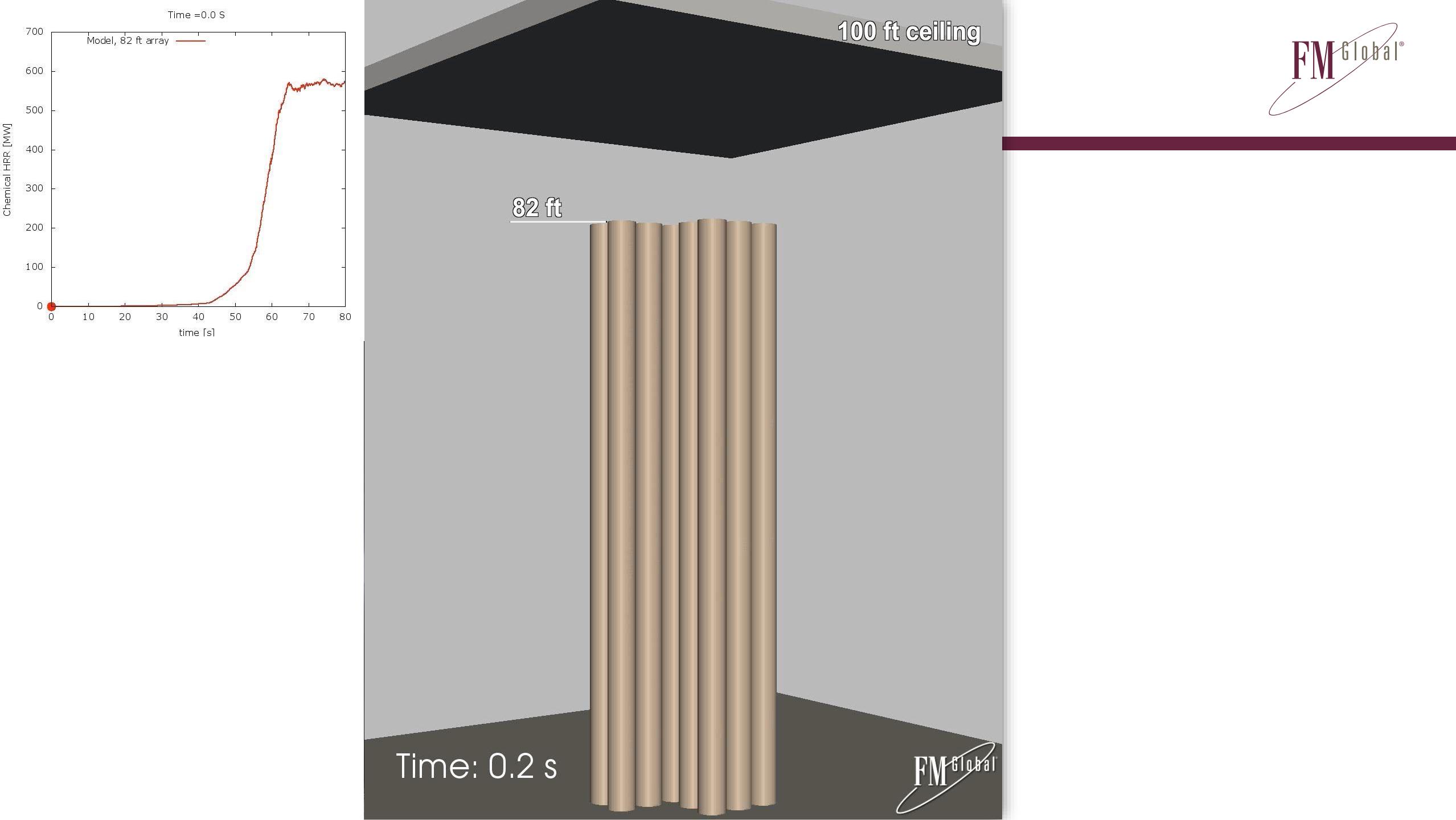


Photo by [Sindre Strøm](#) from [Pexels](#)

Maximising space

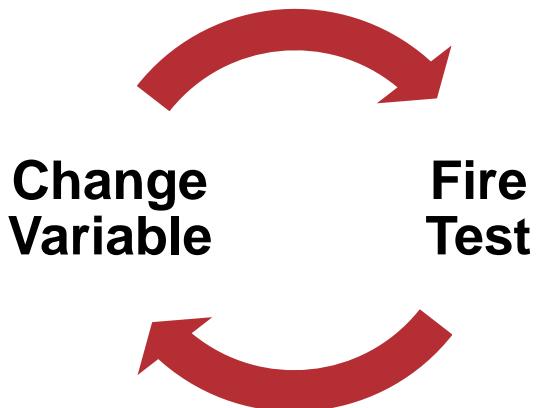








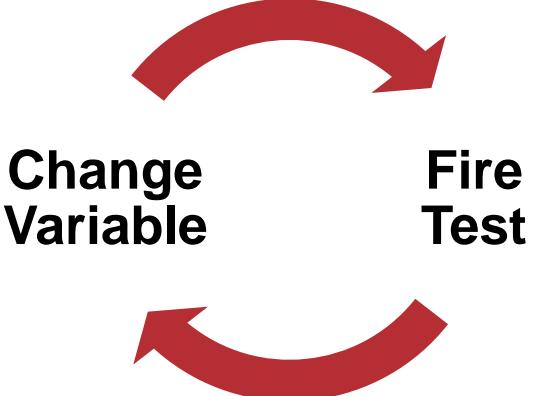
The traditional approach



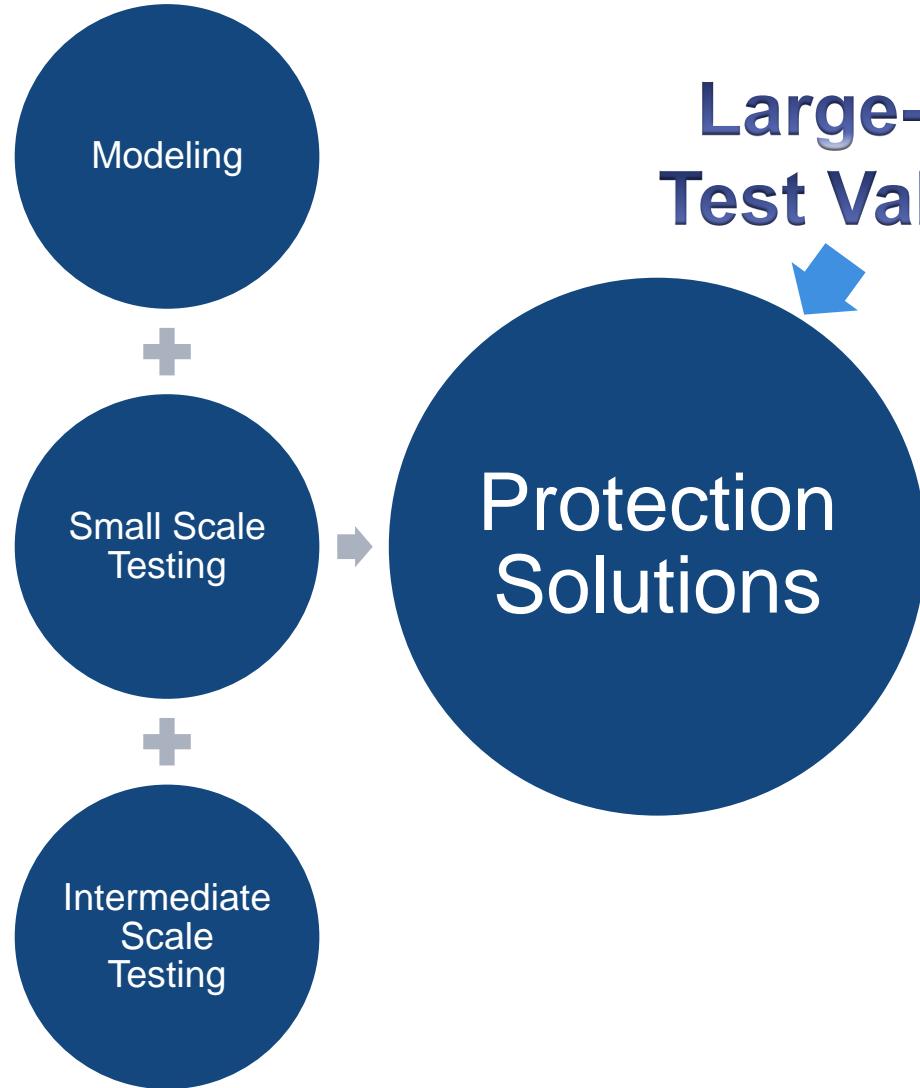
Protection
Guidelines

A new approach

1968 - 2013



2013 - Present



Suppression model



- Full physics-based model
- Series of sub models
- Validation
- Combined sub models
- Validation

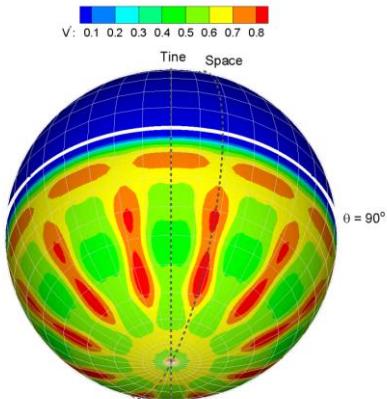




Many parts



Sprinkler Atomization



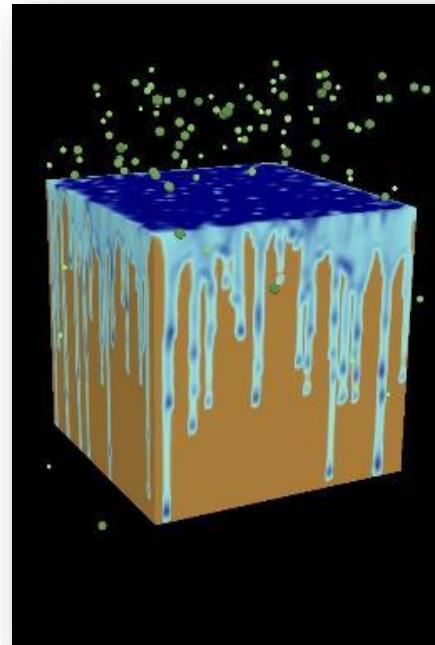
Zhou, et al.

Spray-Plume Interaction



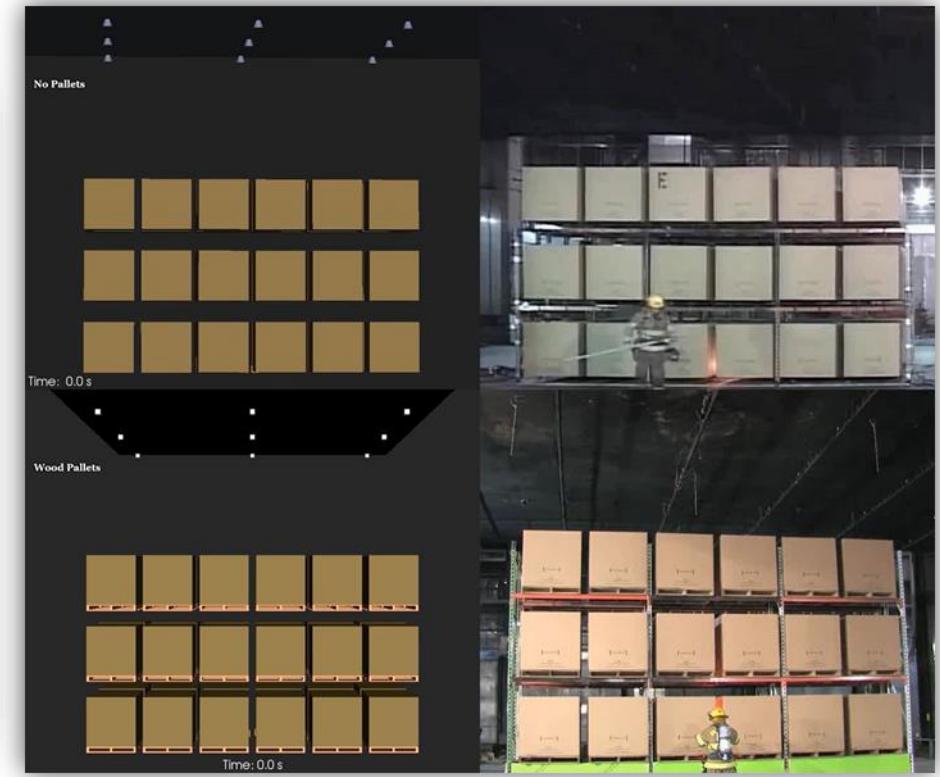
Meredith, et al.

Surface-Film Flow



Meredith, et al.

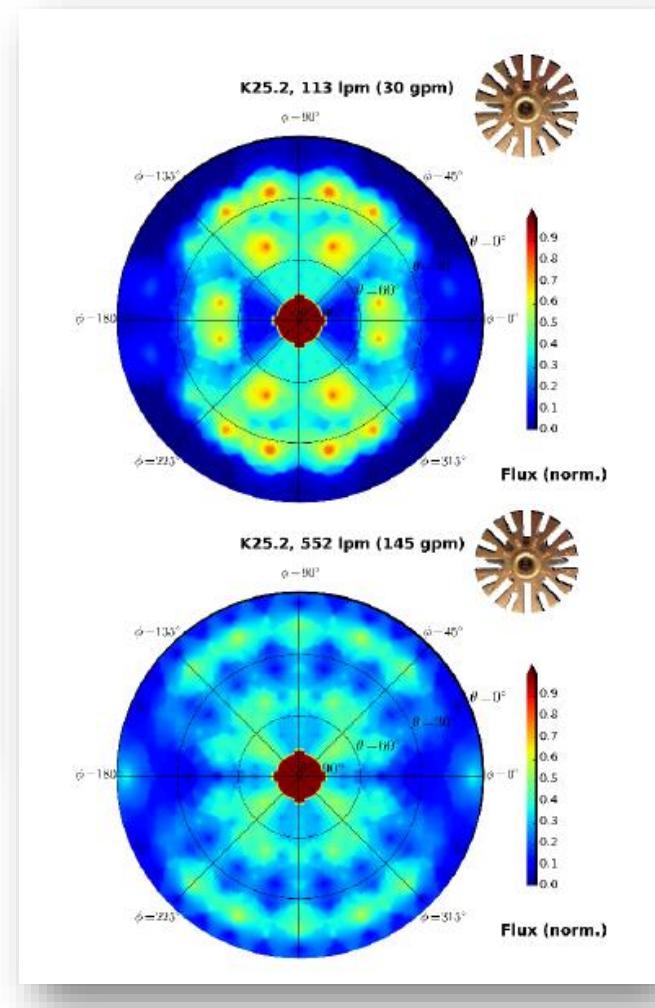
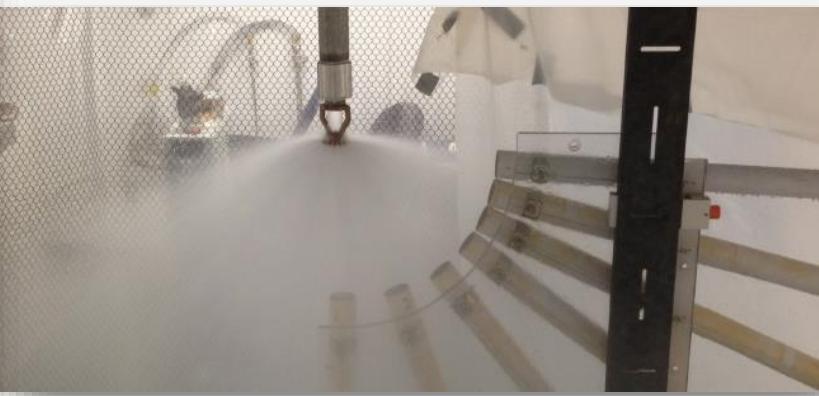
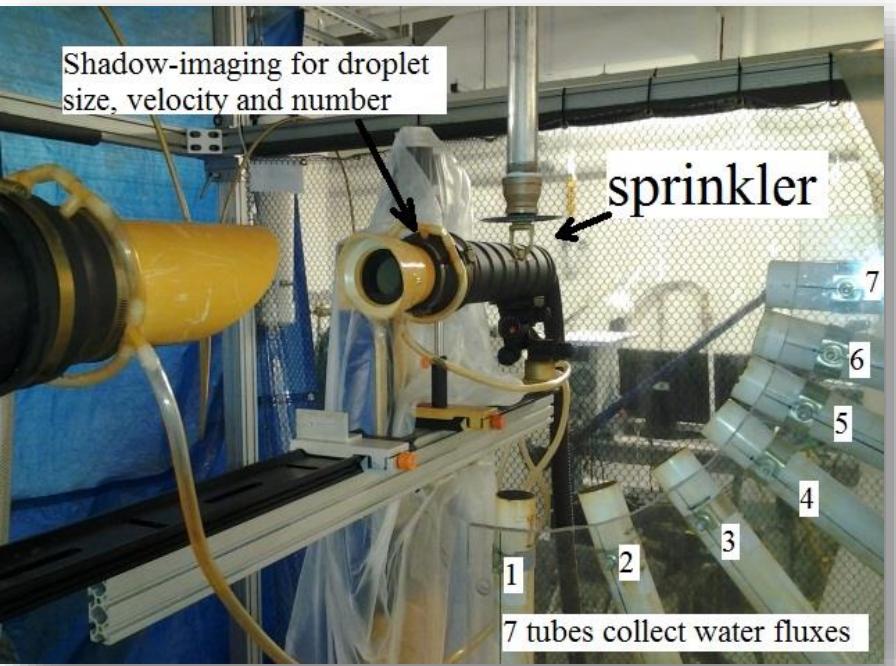
Rack Storage Suppression



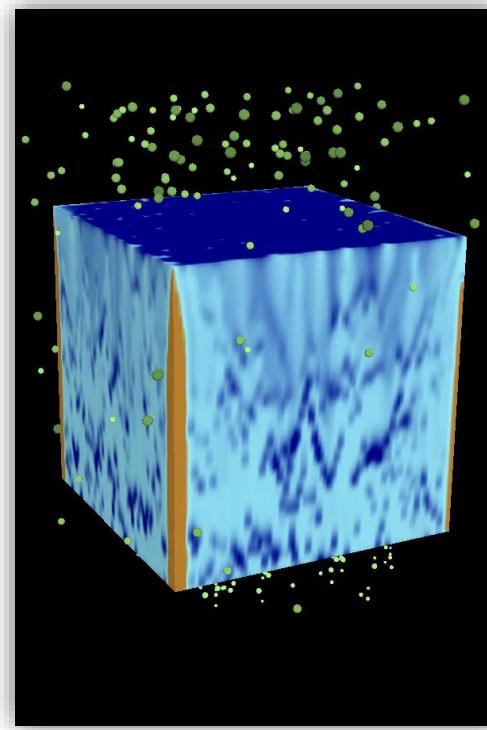
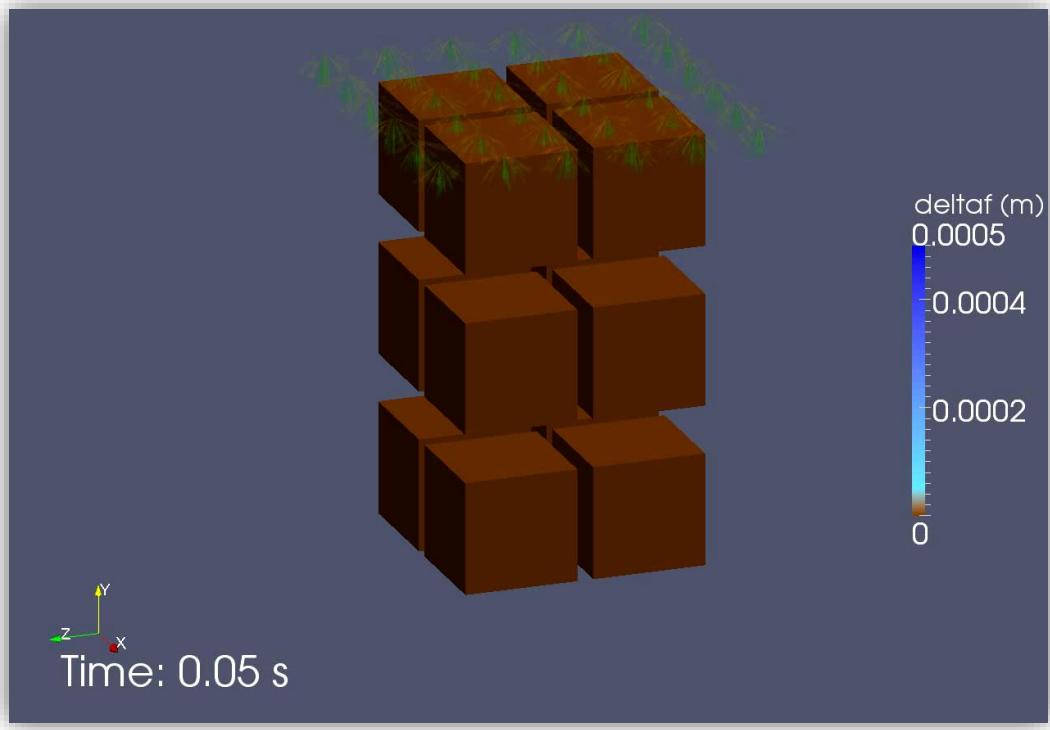
Meredith, Wang, Ren

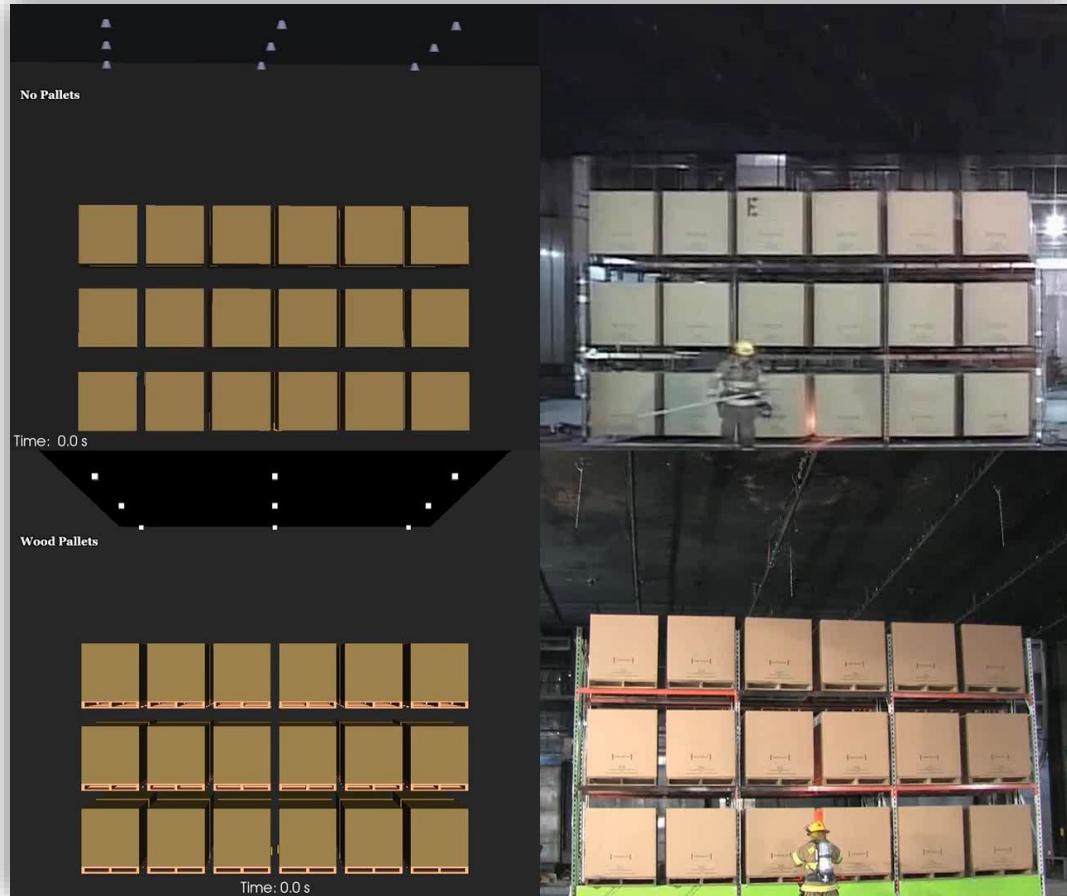
[Open Source Fire Modelling](#)

Water atomisation



Water transport validation





- Class 2 Commodity
- Complex Fuels
 - Non-homogeneous Material
 - Complex Geometries

01010110100101110110110101101101101101101101101101



Available from <http://www.fmglobal.com>

In rack sprinklers

Warehouse growth



Trending towards
increased storage height



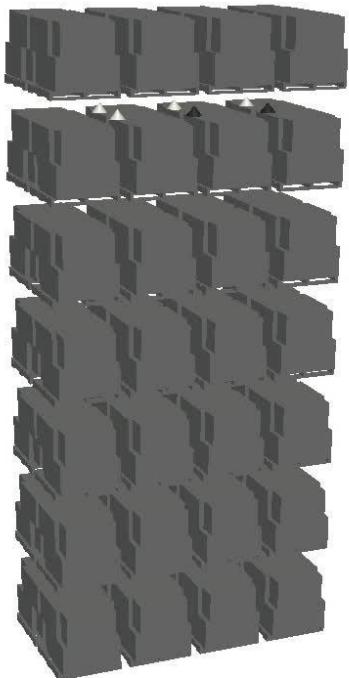
Ceiling-only
Protection Inadequate

- Existing guidance
- Cost/complexity
- Vertical separation
- Flow requirements

Applying the new method

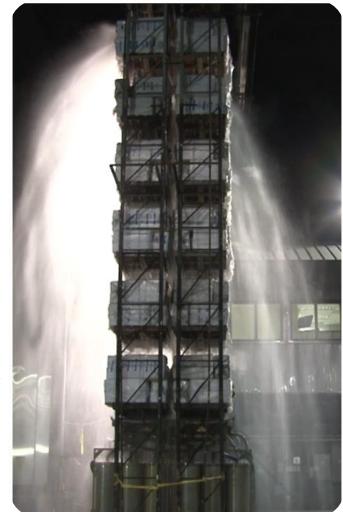


Cold-Flow
Modeling



Time: 0.00

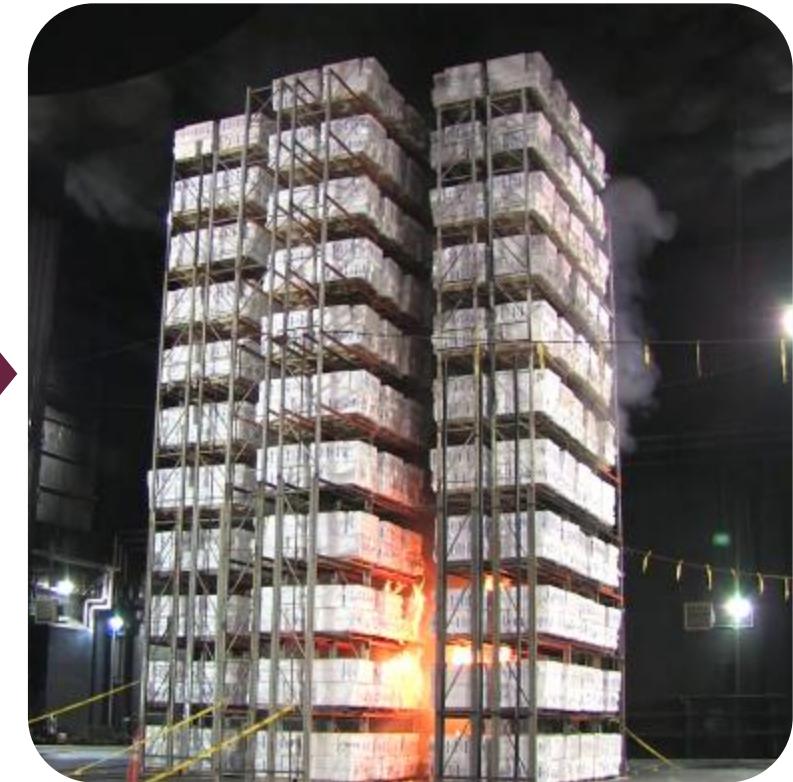
Cold-Flow
Testing



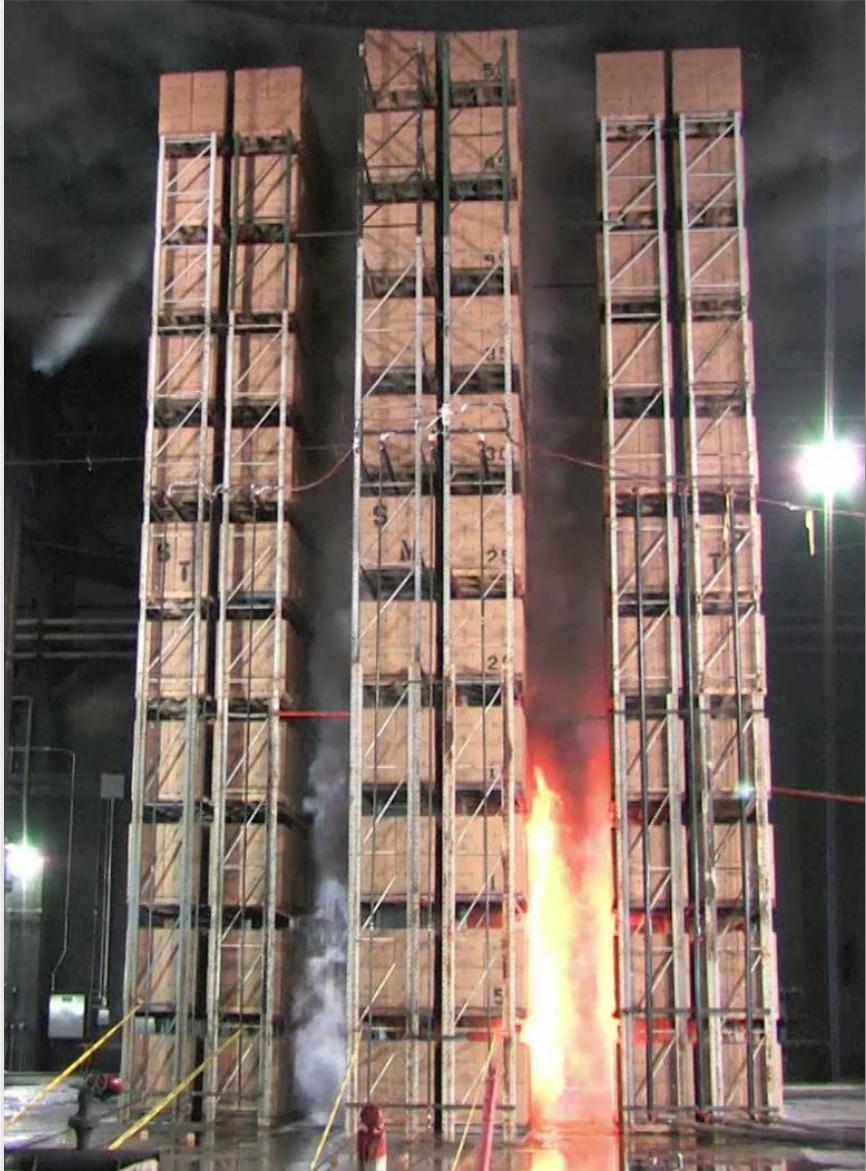
Intermediate-
Scale
Suppression



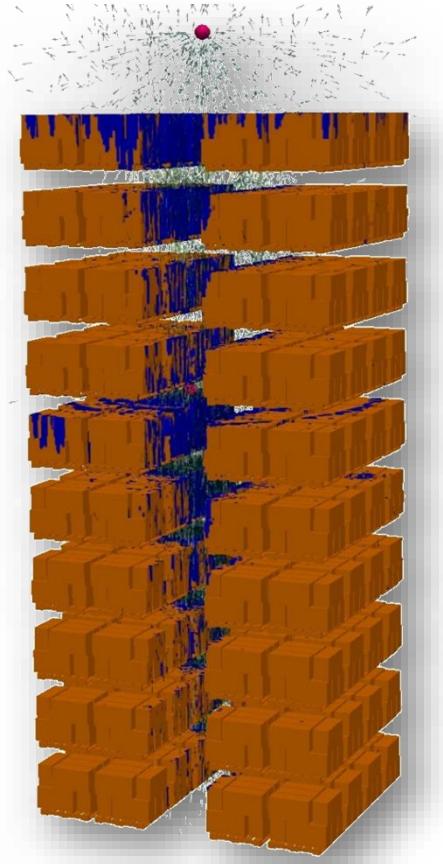
Large-Scale
Suppression



Validated – large scale



- Three commodity types
 - UUP, CUP, UEP
- New vertical separation
 - 9 m – 12 m (30 ft – 40 ft)
- Single large scale test
 - Optimized water flow

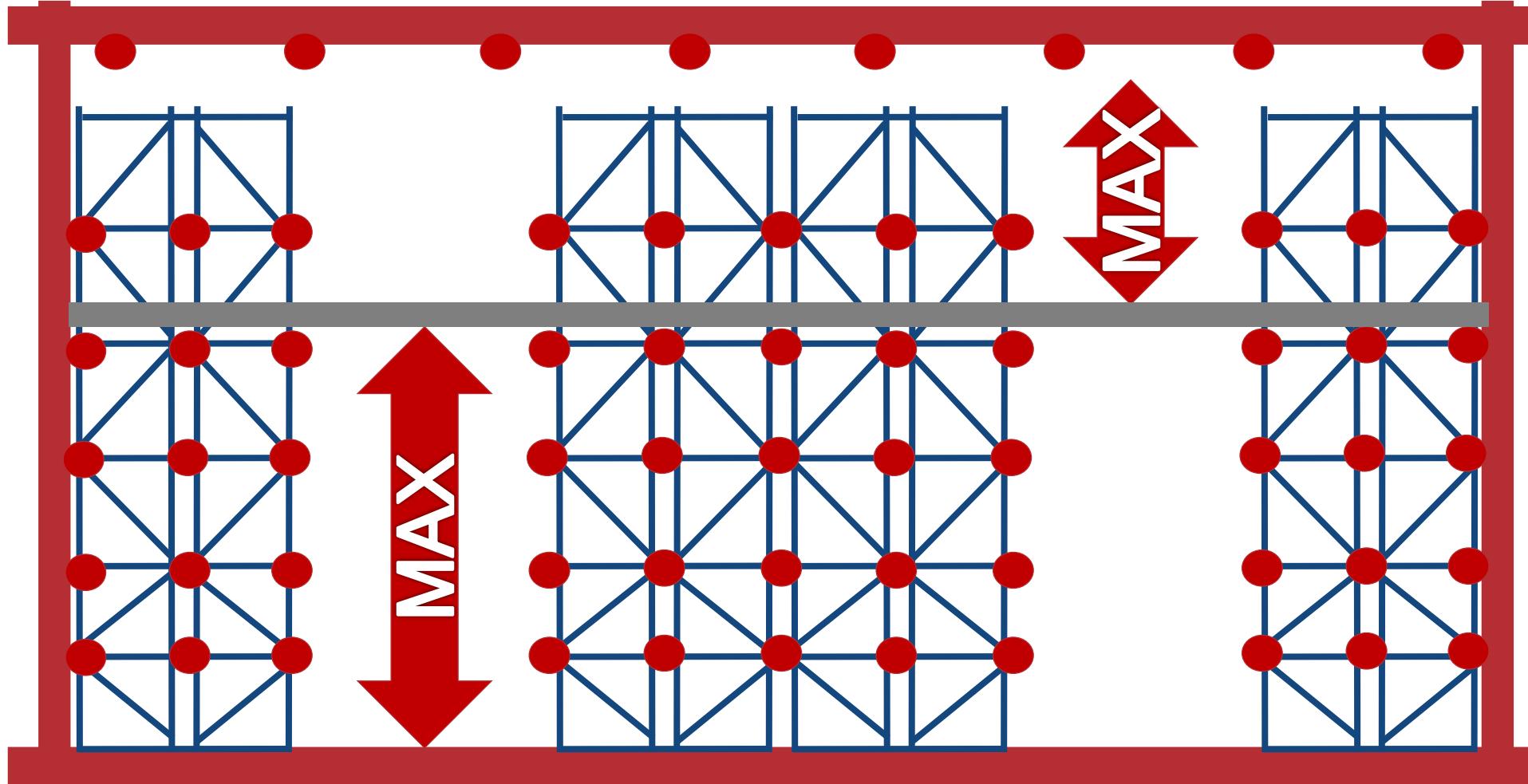


Fundamental Understanding of
In-Rack Phenomena

Demonstrated Coupling of
Modeling & Experimentation



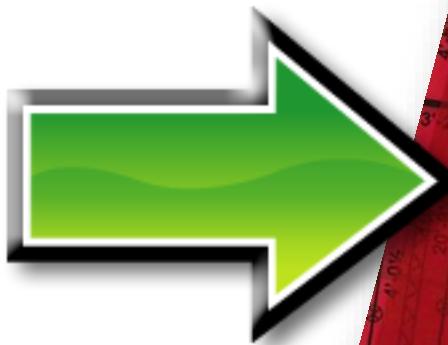
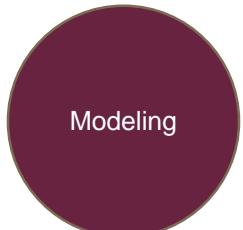
A new theory



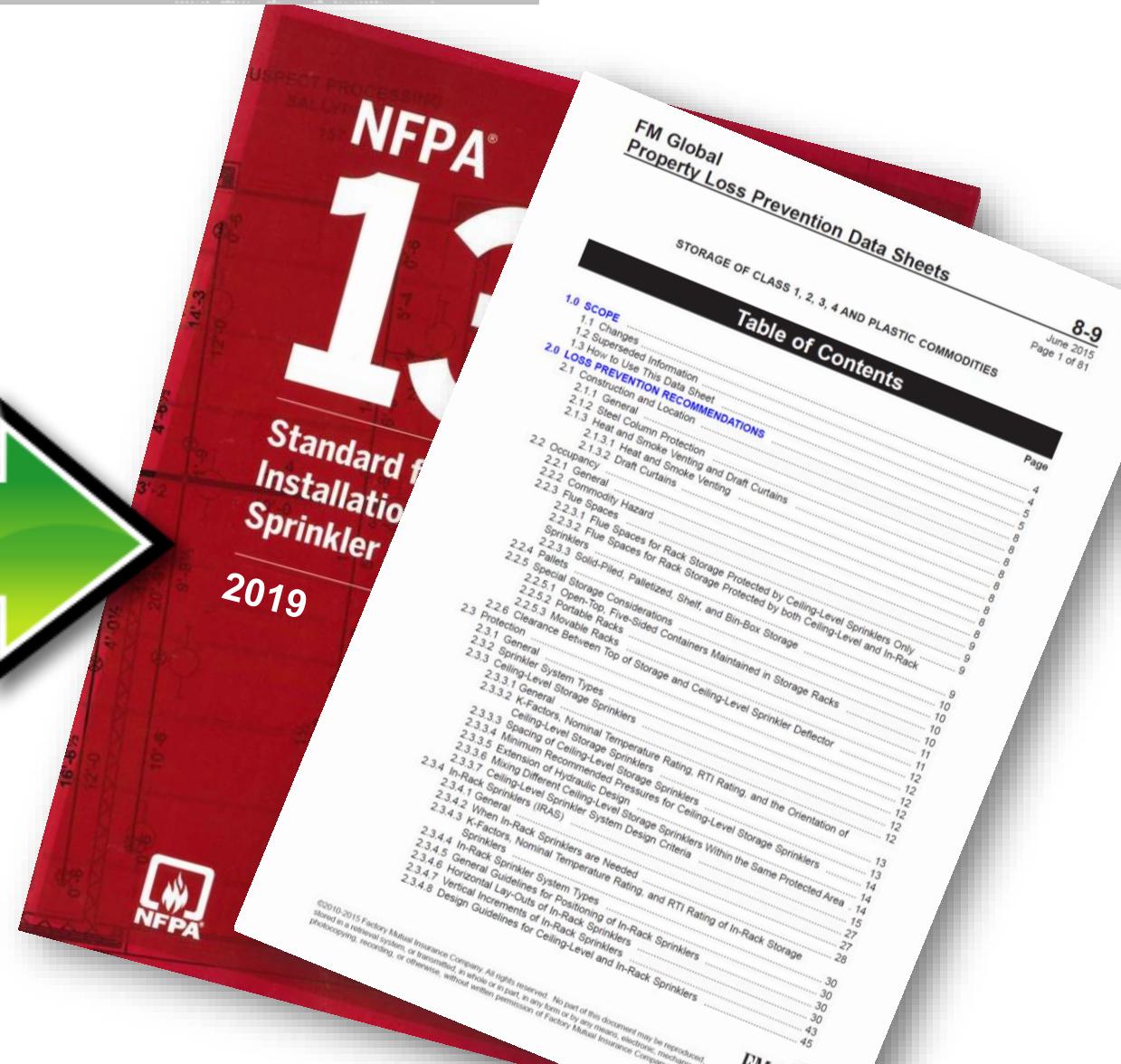
Benefits

- Independent of ceiling
- Same water demand
- Less sprinklers
 - ~ 6 sprinkler design
 - < 3,785 lpm (1,000 gpm) water demand

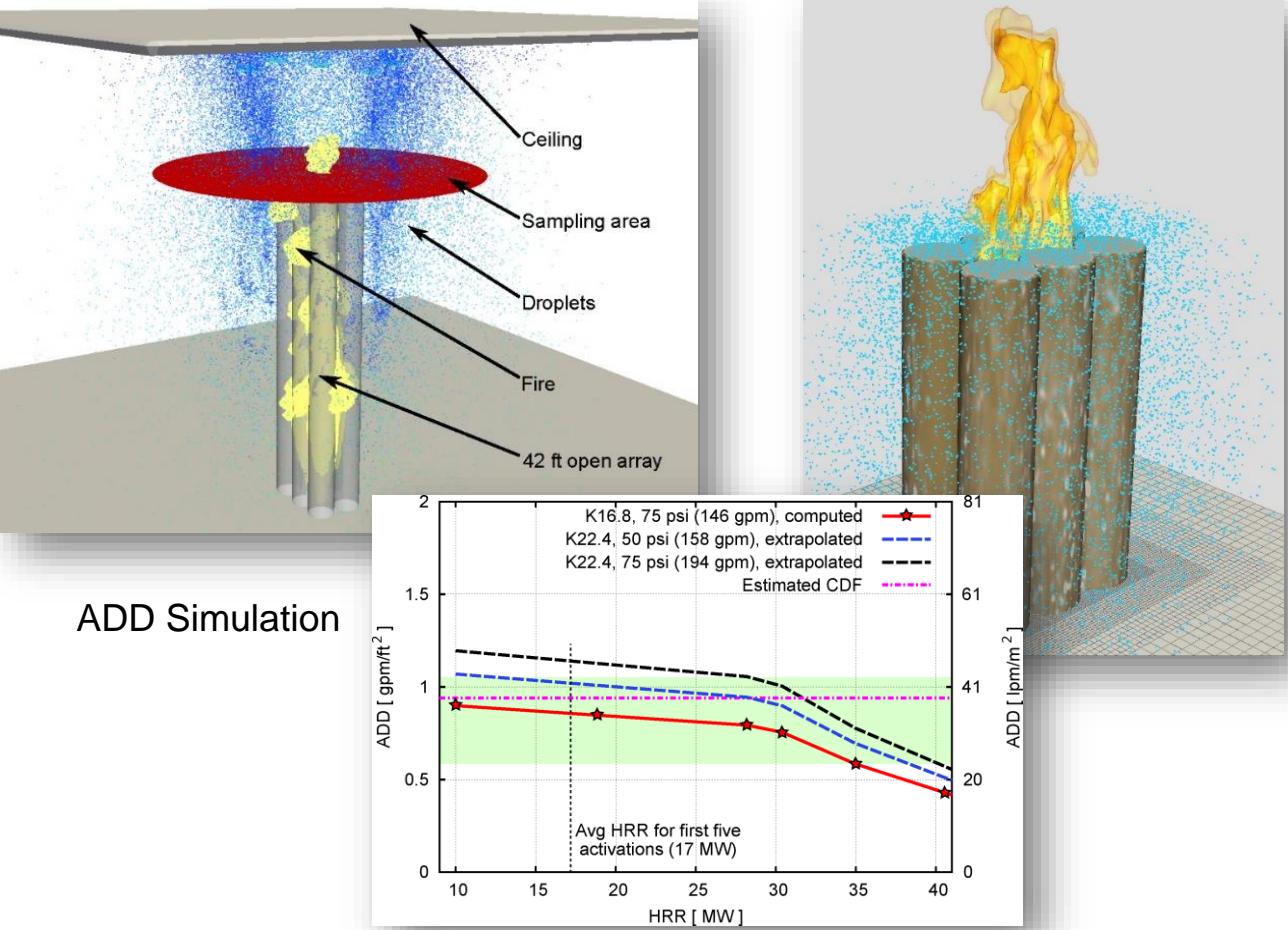
Validated and in standards



FM Global Datasheets



Roll paper suppression

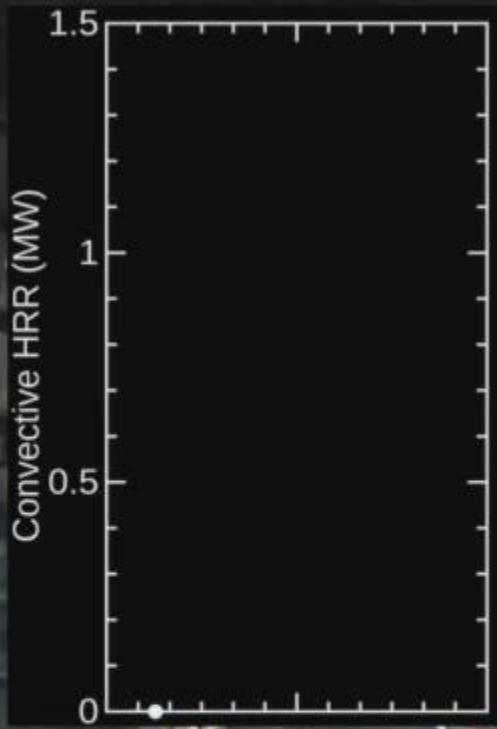


12.8 m (42 ft) open array, 18 m (60 ft) ceiling
26 lb/1000 ft² Kraft paper





Where to next....



Reliable



Can achieve
99.5%

Oxygen reduction systems

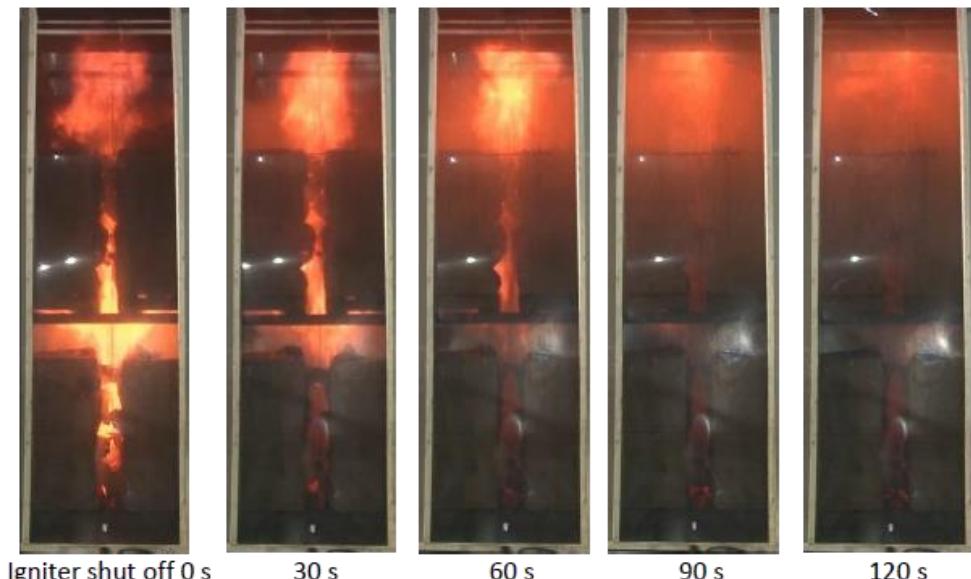


Figure 3-12: Flame images recorded at different times (0 s, 30 s, 60 s, 90 s and 120 s) after the igniter was shut off at 210 s from ignition for Class 3 with 13.0% O₂.

SMART sprinklers

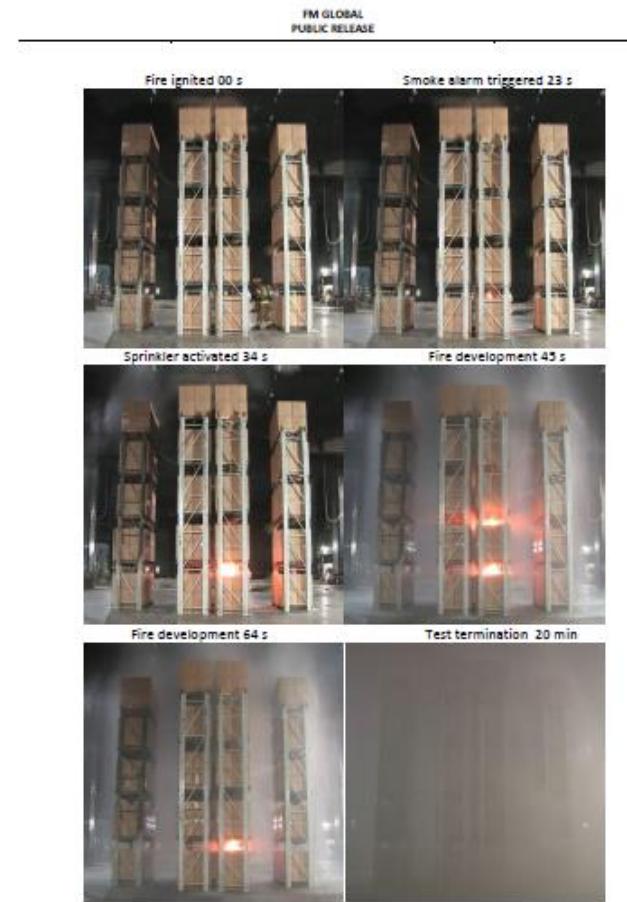


Figure 3-8: Fire development in Test 2 [K200, 26.5 mm/min (K14.0, 0.65 gpm/ft²)].

[FM Global Research Technical Reports](#)



Another technology?





Future

2019 2020 2023 2021

2022 2023 2024 2025

2026 2027 2028 2029

2030 2031 2032 2033



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