



UPDATE: DEVELOPMENT OF SPRINKLER PROTECTION FOR LIB ENERGY STORAGE SYSTEMS

Ben Ditch

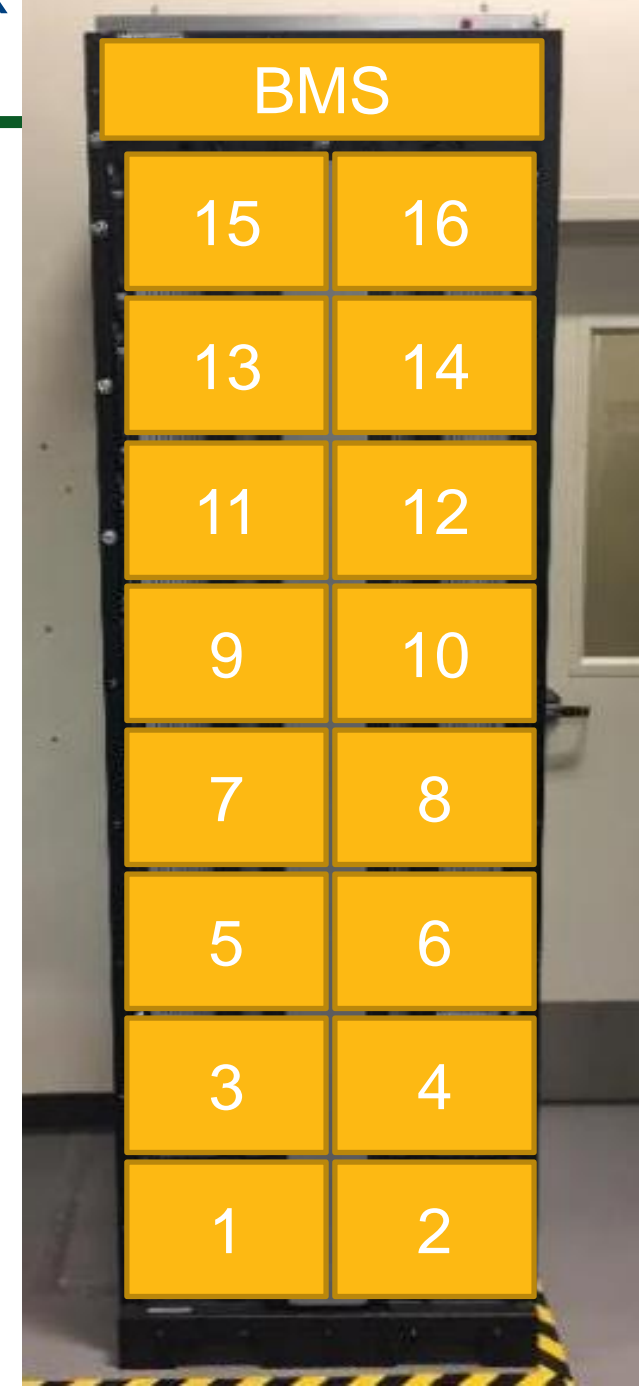


Determine sprinkler protection guidance for ESS located within commercial occupancies.

- **Task 1:** Determine an ignition scenario to induce thermal runaway via small-scale tests at the ESS module level.
- **Task 2:** Conduct free-burn fires to provide a hazard assessment representative of the wide range of commercial ESS designs.
- **Task 3:** Evaluate sprinkler system performance that applies to the majority of locations where an ESS may be found within a commercial occupancy.

Battery Description		
Chemistry	LFP	LMO / NMC
Capacity (Ah)	20	32.5
Voltage (VDC)	3.3V	3.75
Format	Prismatic	
Module Description		
Capacity (Ah)	120	130
Voltage (VDC)	42.9	60
Battery Quantity	78	64
Rack Description		
Voltage (VDC)	686	960
Module Layout	2 wide x 8 tall	

Footprint: ~30 in. wide x 30 in. deep



Ignition

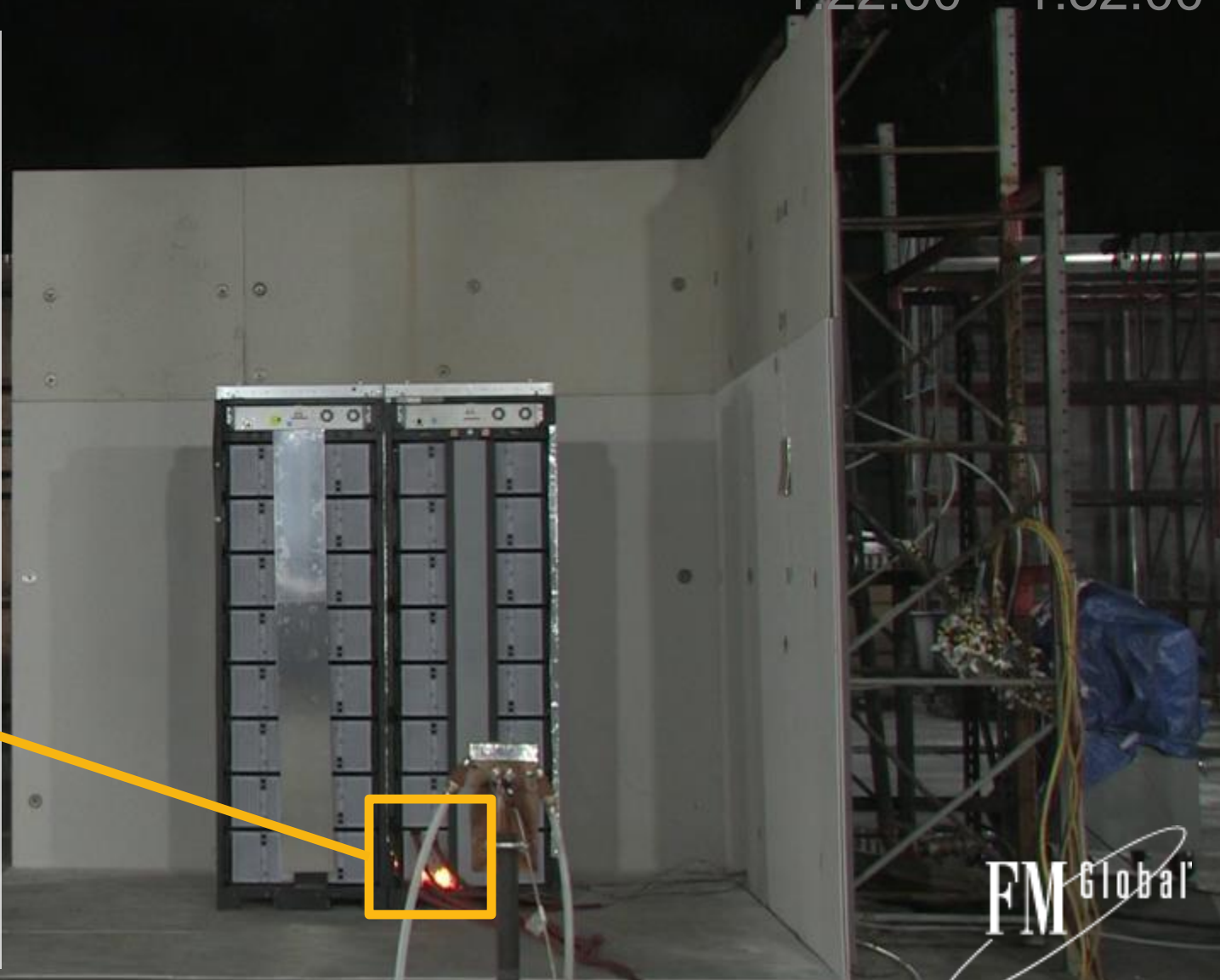
1:22:00 – 1:32:00



Ignition

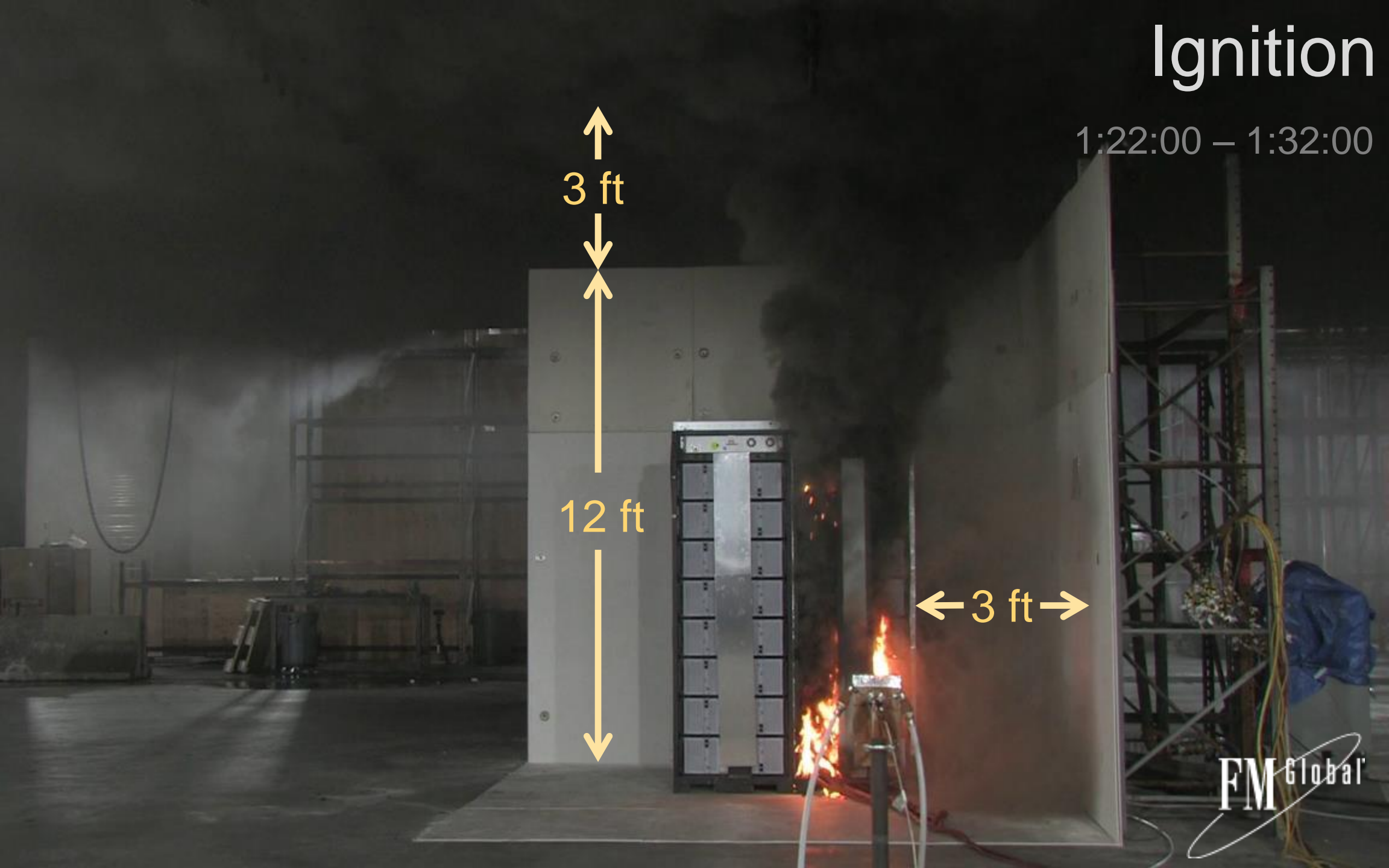
1:22:00 – 1:32:00

- Overheat bottom half of module
 - Three heaters, 1" wide × 12" long
 - 5°C/min



Ignition

1:22:00 – 1:32:00



↑
3 ft

↓

↑

12 ft

↓

← 3 ft →

Sprinkler Protection

Water Demand*

- NFPA 13
 - EH1: 0.3 gpm/ft² (12 mm/min)
 - EH2: 0.4 gpm/ft² (16 mm/min)
- DS 3-26
 - HC-3: 0.3 gpm/ft² (12 mm/min)
 - Ceilings < 30 ft (9.1 m)

*Demand area typically ≥ 2500 ft² (230 m²)

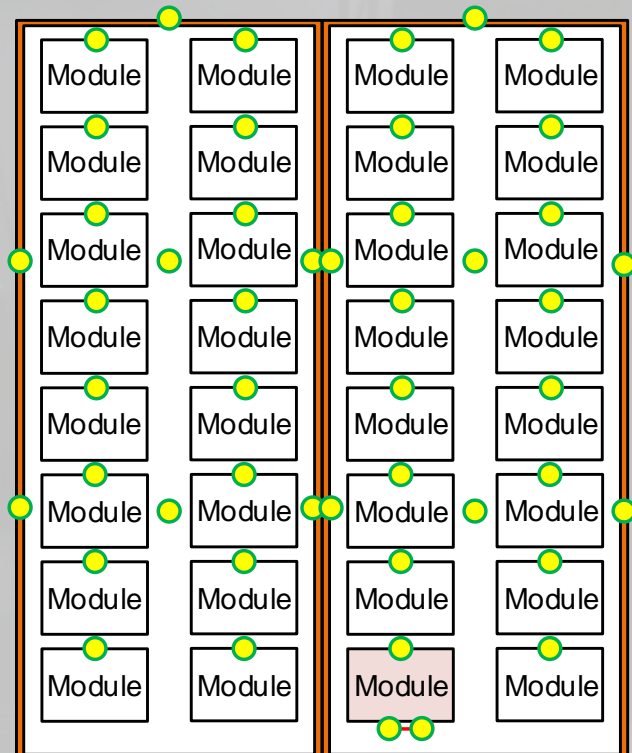
Sprinkler System Design

- K5.6 gpm/psi² (81 lpm/bar^{1/2})
- 0.3 gpm/ft² (12 mm/min)
- 155°F (70°C)
- QR, Pendent
- Ceiling-to-link: 1 ft (0.3 m)
- Spacing: 10 × 10 ft (3 × 3 m)

Sprinkler Operation

1:34:00 – 1:44:00

- Temperature
 - Modules
 - Rack walls

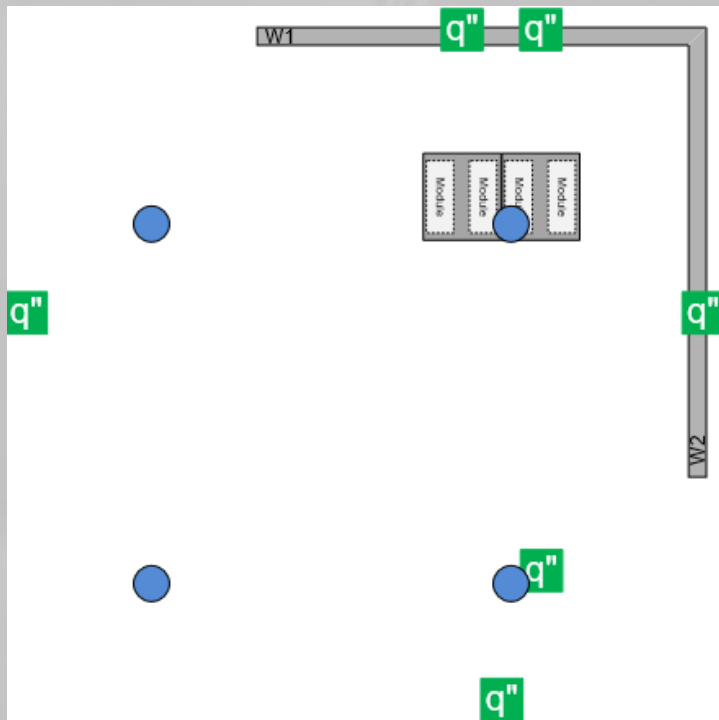


Sprinkler Operation

1:34:00 – 1:44:00

- Heat flux

- Surroundings
- Corner wall



Near Peak HRR

1:44:00 – 1:45:00



Evaluation Criteria

- Sprinkler operations
- Heat flux at:
 - Room corner walls
 - Surrounding equipment
- Temperature at:
 - Side walls of the ESS
 - Ceiling and steel TCs

Heat Flux Threshold

- Noncombustible surfaces/items
 - $\leq 27 \text{ kW/m}^2$
 - ~ represents damage steel / glass
- Combustible surfaces
 - $\leq 12.5 \text{ kW/m}^2$
 - ~ nominal critical value for ignition of cellulosic and plastic materials

No pass/fail criteria

Additional Considerations

- Extent of damage to battery modules based on post-test inspection
- Total energy release and heat flux compared to free-burn
- Reignition

Reignition

3:02:30 – 3:03:30



2nd Peak HRR

3:12:00 – 3:12:30



FM Global

Comparison at Peak Exposure

NMC



LFP



Summary

Work in Progress

- Developing sprinkler protection guidance for ESS
- Conducted large-scale free burn and sprinklered fire test on two ESS chemistries
- Identify additional installation considerations
- Full report and videos will be publicly available