# New Solutions in Sprinkler Protection:

- Lithium-Ion Battery Production Facilities
- Reducing the Distance Between Racks in Warehouses


Reliable®

**Guy Watson**
IRMCert GIFireE

***Technical Director EMEA***
Reliable Automatic Sprinkler Company


# What We Will Cover Today…

- **Introductions** *(2 Minutes)*
- **New Solutions in Sprinkler Protection:**
  - **Reliable N28T6 & T3** - *CMSA storage sprinkler for densely-packed warehouses (12 minutes)*
  - **Reliable LB11** - *developed for protection of lithium-ion batteries in manufacturing facilities (14 minutes)*
- **Questions** *(2 Minutes)*

# About Your Presenter…

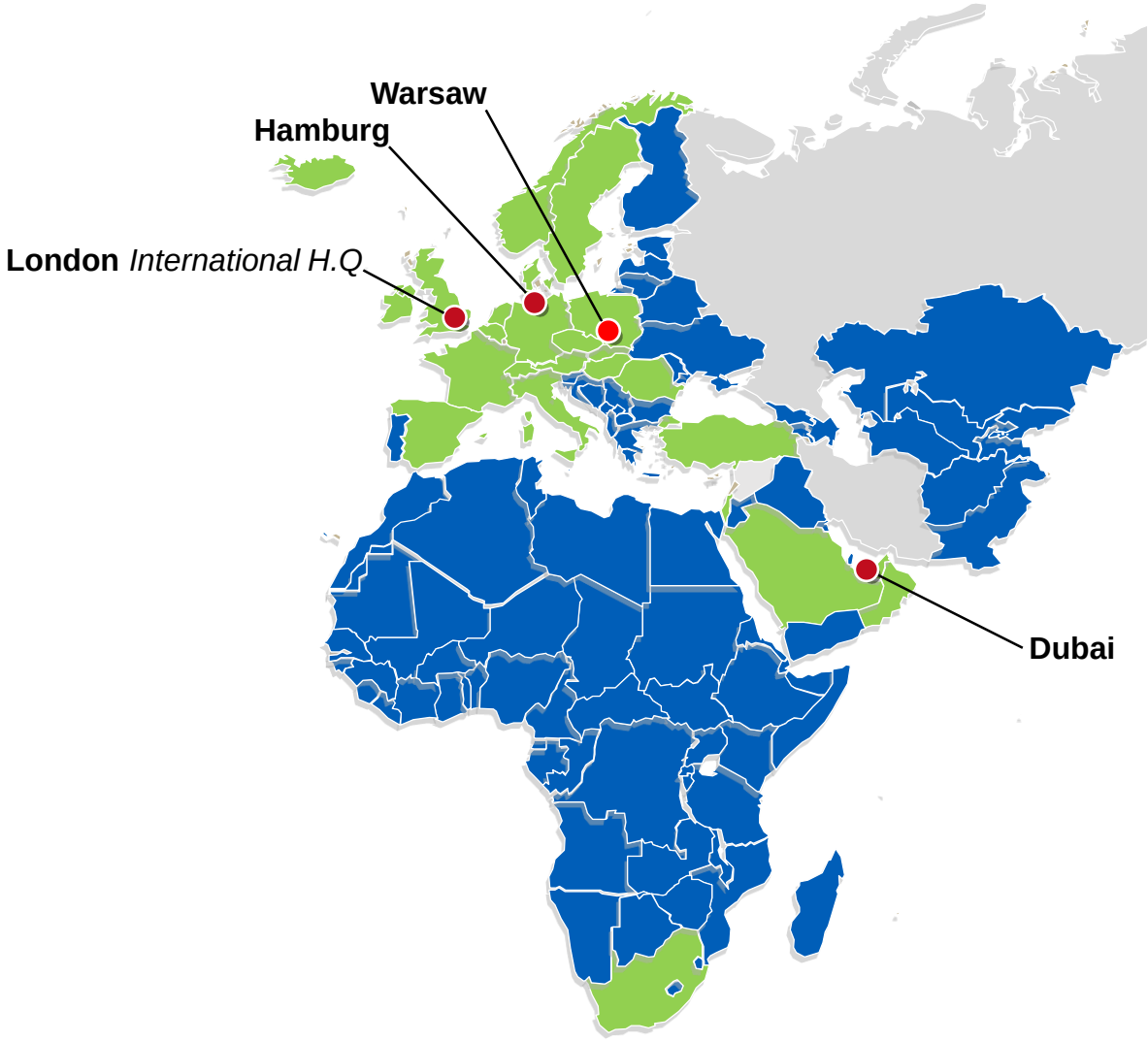
*Guy Watson, IRMCert, GIFireE*
*Technical Director, EMEA*


Grandson

Son

Father

*3 Generations of Watsons in Sprinklers!*



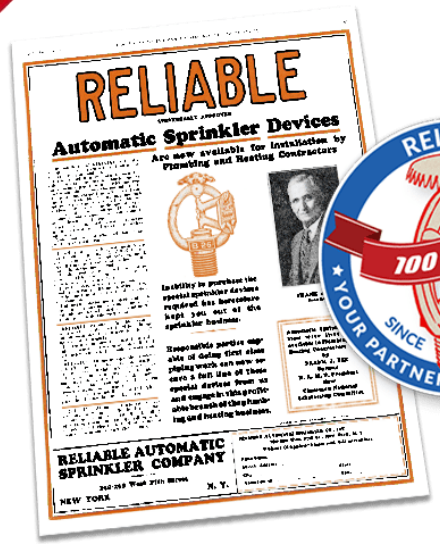

*Visited Recently*

**Reliable®**

**www.reliablesprinkler.com**

# About Reliable…

*USA Family-Owned For Over a Century!*








**Reliable®**

**www.reliablesprinkler.com**






- Key Points:
- Everything has to evolve to survive – including sprinkler protection
- To survive 100 years, Reliable has had to continually innovate


# A Legacy of Innovation…

- Key Point:
- All of these products were once new and sometimes had to struggle to be accepted

- 1921 – **Frangible Glass Bulbs**
- 1925 – **Grooved Couplings**
- 1950 – **Spray Pattern Sprinklers**
- 1956 – **Pre-Action Systems**
- 1972 – **Full Hydraulic Calculations**
- 1976 – Domestic Sprinklers
- 1979 – **Large Drop Sprinklers**
- 1984 – CPVC Pipe & Fittings
- 1987 – **EC & ESFR Sprinklers**
- 1999 – Flexible Sprinkler Hoses
- 2006 – In-Rack Barriers
- 2018 – NFPA13 & FM 8-9 Large Orifice In-Rack Schemes


# A Legacy of Innovation…

- Key Point:
- Great care is required to ensure that new products do not erode the unrivalled legacy for reliability that sprinklers have earned

- 1921 – **Frangible Glass Bulbs**
- 1925 – **Grooved Couplings**
- 1950 – **Spray Pattern Sprinklers**
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- 1999 – Flexible Sprinkler Hoses

- 2006 – In-Rack Barriers
- 2018 – NFPA13 & FM 8-9 Large Orifice In-Rack Schemes
- New Risks, New Technologies, New Products

# New Solutions in Sprinkler Protection:

- **Reducing the Distance Between Racks in Warehouses**


Image:
panattonieurope.com/

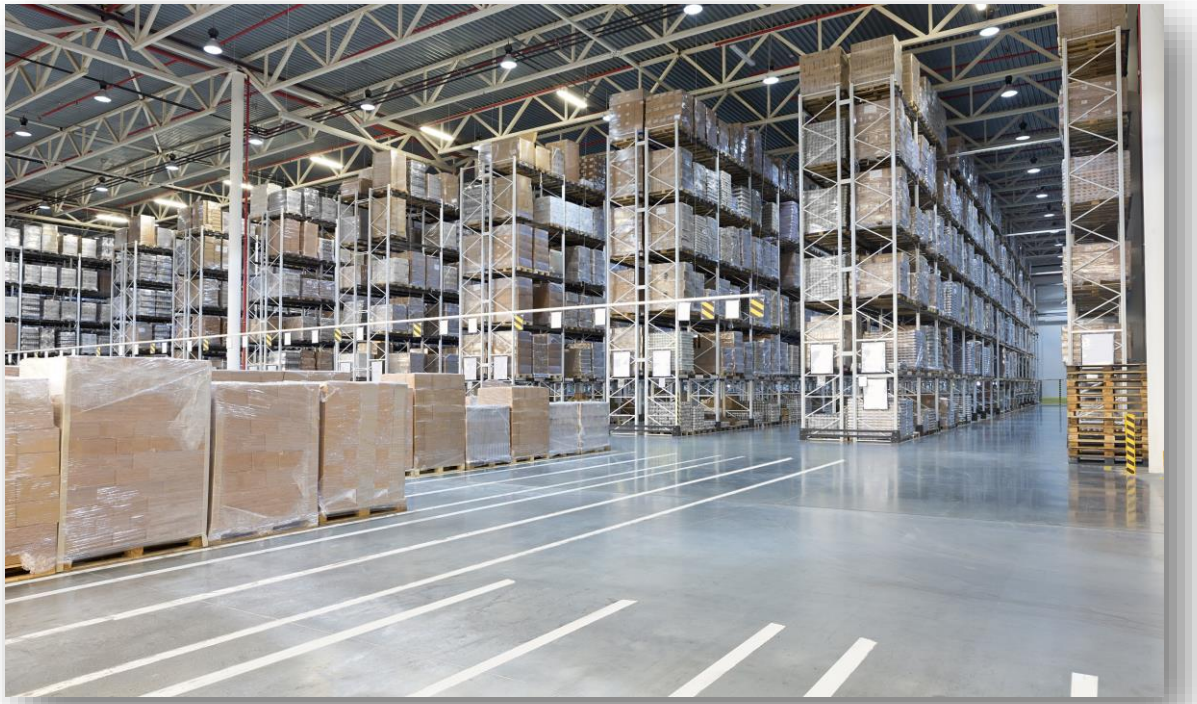
# Logistics Warehouses are Continually Evolving…

Key Points:

- Increased demand for storage & increased land prices, create the need for higher and denser storage arrays, to maximise warehouse capacity

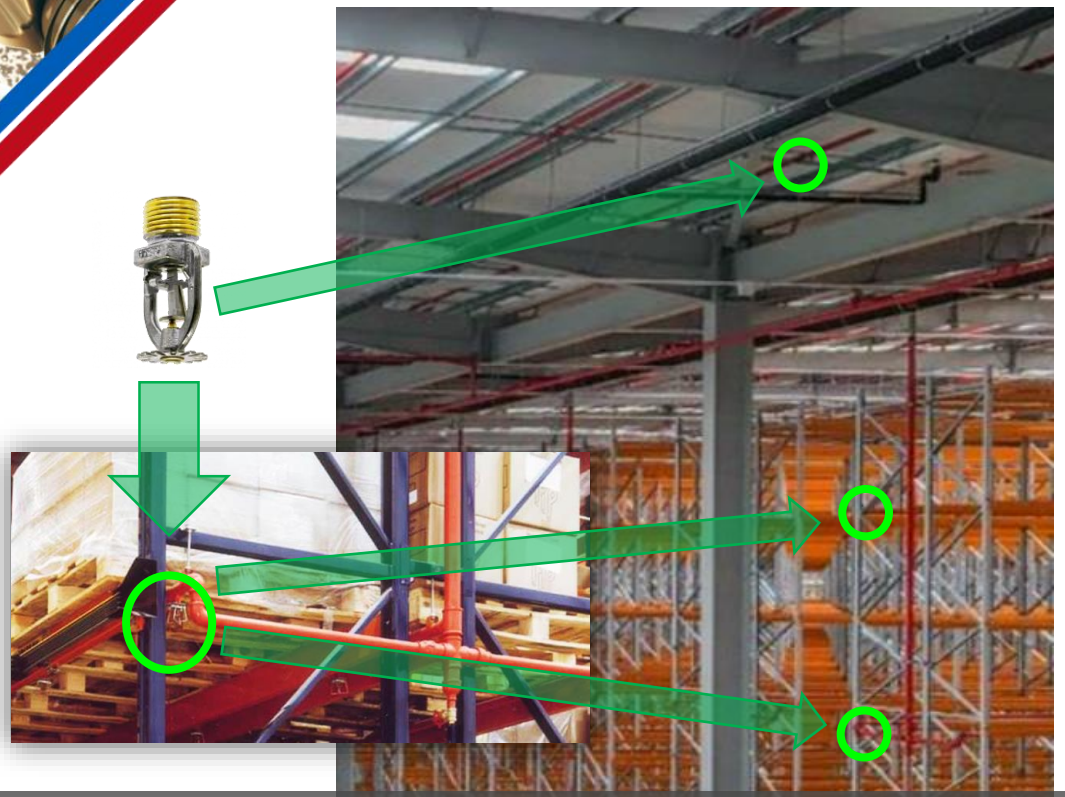
Old North-Light Roof Warehouse

Modern High-Bay Warehouse

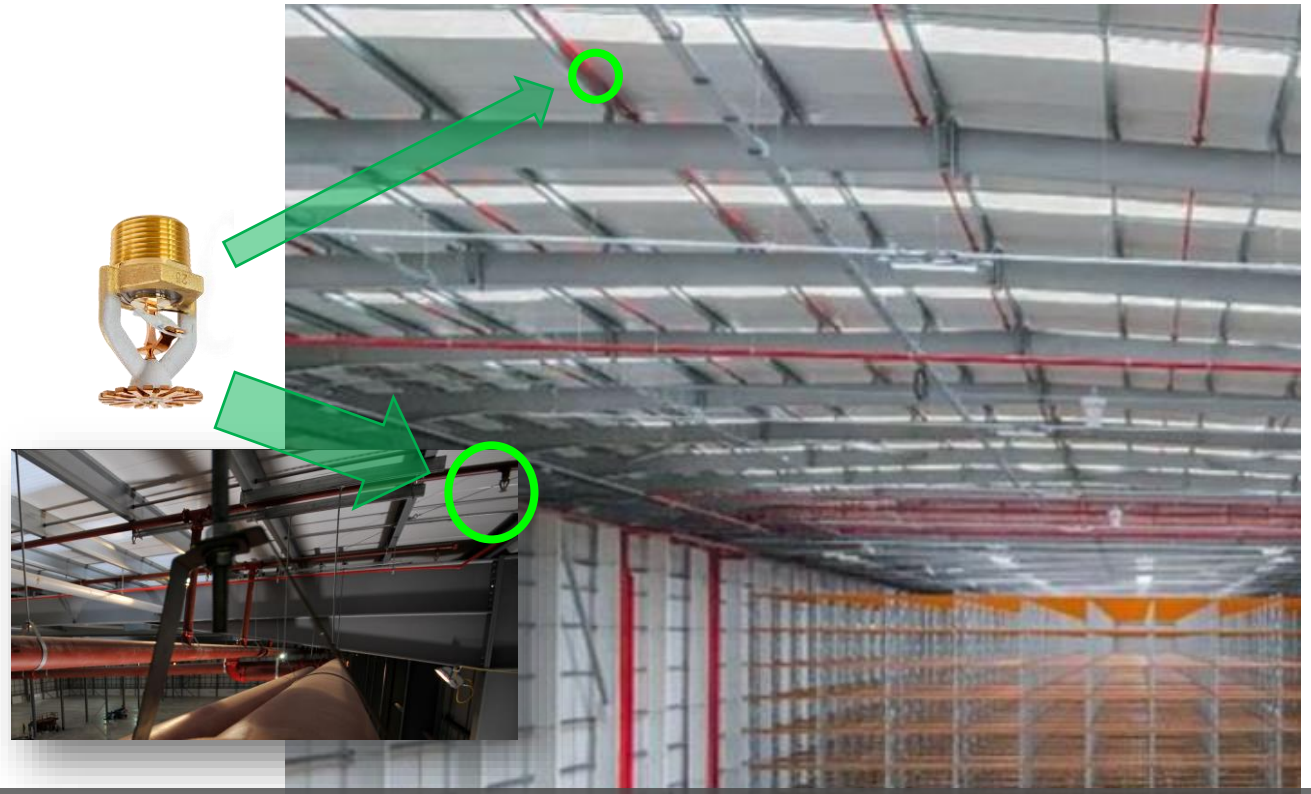


# Sprinkler Protection Has Evolved Too…

Roof & Rack Sprinkler Protection



Ceiling-Only Protection

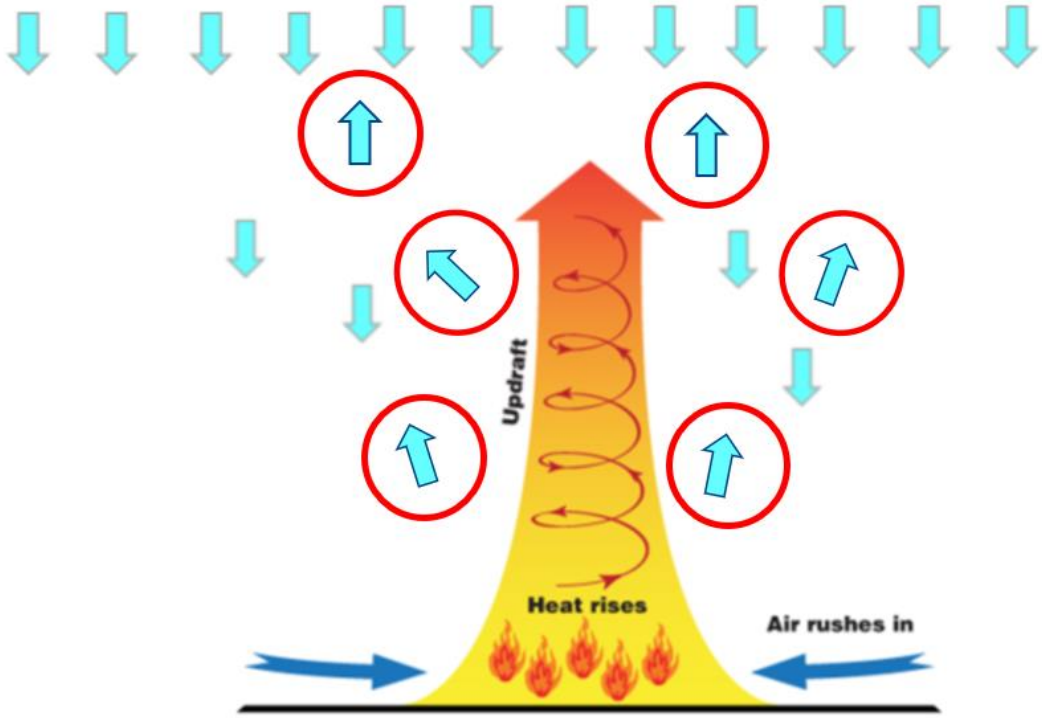


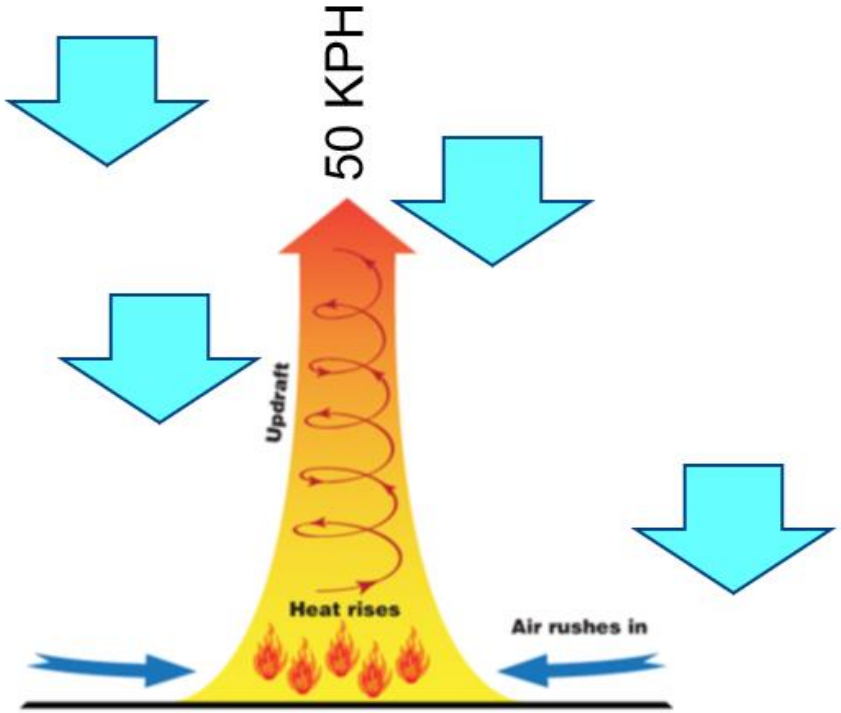
- Key Points:
- Traditional solutions use 15-20mm sprinklers every other level in racks balanced with ceiling level sprinklers above racks
- ESFR (25mm) arrived in the 1990's allowing ceiling only sprinklers to protect up to 10.8m storage / 12.2m ceiling
- Control Mode Specific Application sprinklers arrived in the early 2000's to protect up to 13.1m storage / 14.6m ceiling
- Latest FM ceiling only solutions allow ceiling only sprinklers to protect up to 15.2m storage / 16.8m ceiling
- Other schemes use ESFR in rack, 9-12m vertically between levels independent of ESFR at ceiling level above racks

# Ceiling Only Options:

***What's the limit? – Recap - Importance of Droplet Size***

- Key Points:
- Smaller K Factor = smaller droplets with lower mass
- Large K Factor = larger droplets with higher mass
- Large fires need larger droplets to penetrate through updraught from convection



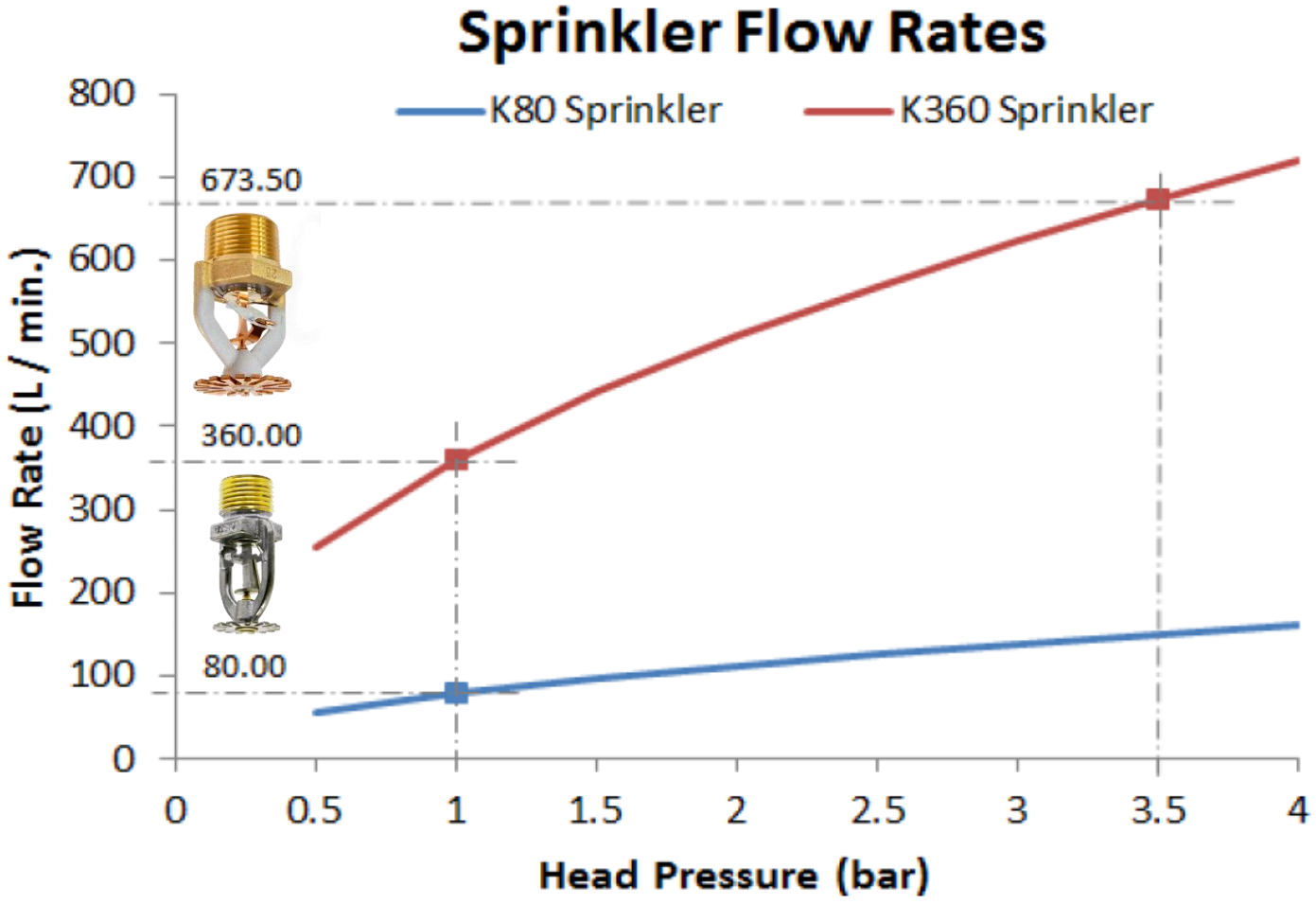



# Ceiling Only Options:

***What's the limit? – Recap - Importance of K-Factor***

**Key Point:**

- The high flows required for ceiling-only protection mean efficiency drops exponentially with height




- Larger K Factors produce more flow for the same pressure, i.e.: a K80 sprinkler will produce a flow 80lpm at 1.0 bar, if the pressure is increased to 3.5 bar, the flow increases only marginally
- A K360 sprinkler will produce a flow 360lpm at 1.0 bar, if the pressure is increased to 3.5 bar, the flow increases to 673lpm
- Increasing ceiling height from 9.1m to 10.6m (+17%) increases water demand by >50%
- Increasing ceiling height from 9.1m to 14.6m (+60%) increases water demand by >140%!

# Ceiling Only Options – What's the Limit?

***Reliable HL22 Was the first CMSA sprinkler for 14.8m Ceilings / 13.1m storage***

# Evolution of UL CMSA Sprinklers for 14.6m Ceiling / 13.1m Storage

***From the Reliable HL22 to the Reliable N28T3***

| | Reliable | Manuf. A | Manuf. B | Manuf. C |
|---|---|---|---|---|
| Model | HL22 | | | |
| K-Factor | 320 | 360 | 360 | 360 |
| Temperature | 74º / 100º | 74º / 100º | 100º | 74º / 100º |
| Commodity | Class I-IV, CUP | Class I-IV, CUP | Class I-IV, CUP | Class I-IV, CUP |
| Palletized | √ | √ | √ | √ |
| Solid Pile | √ | √ | √ | √ |
| Single-Row Racks | √ | √ | √ | √ |
| Double-Row Racks | √ | √ | √ | √ |
| Multiple-Row Racks | | | √ | |
| Portable Racks | | | √ | |
| Aisle Width | 2.4m | 1.5m | 1.2m | 1.5m |
| Flues | 150mm | 150mm | 150mm | 150mm |
| Design psi | 3.8 Bar | 3.1 Bar | 3.1 Bar | 3.1 Bar |
| Total Flow | 7486 lpm | 7606 lpm | 7606 lpm | 7606 lpm |

# Ceiling Only Options – What's the Limit?

## *FMD 8-9 Table 17b*

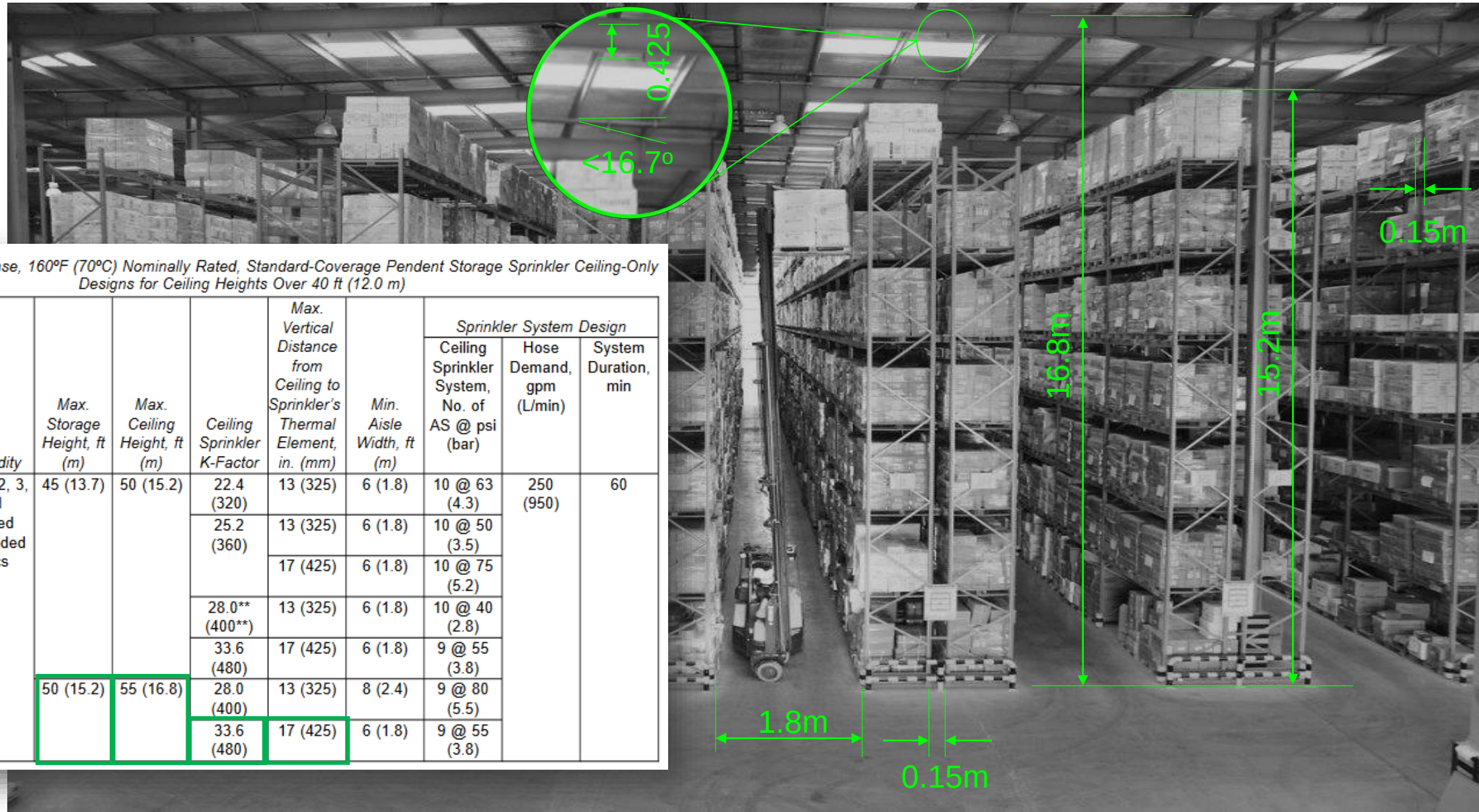
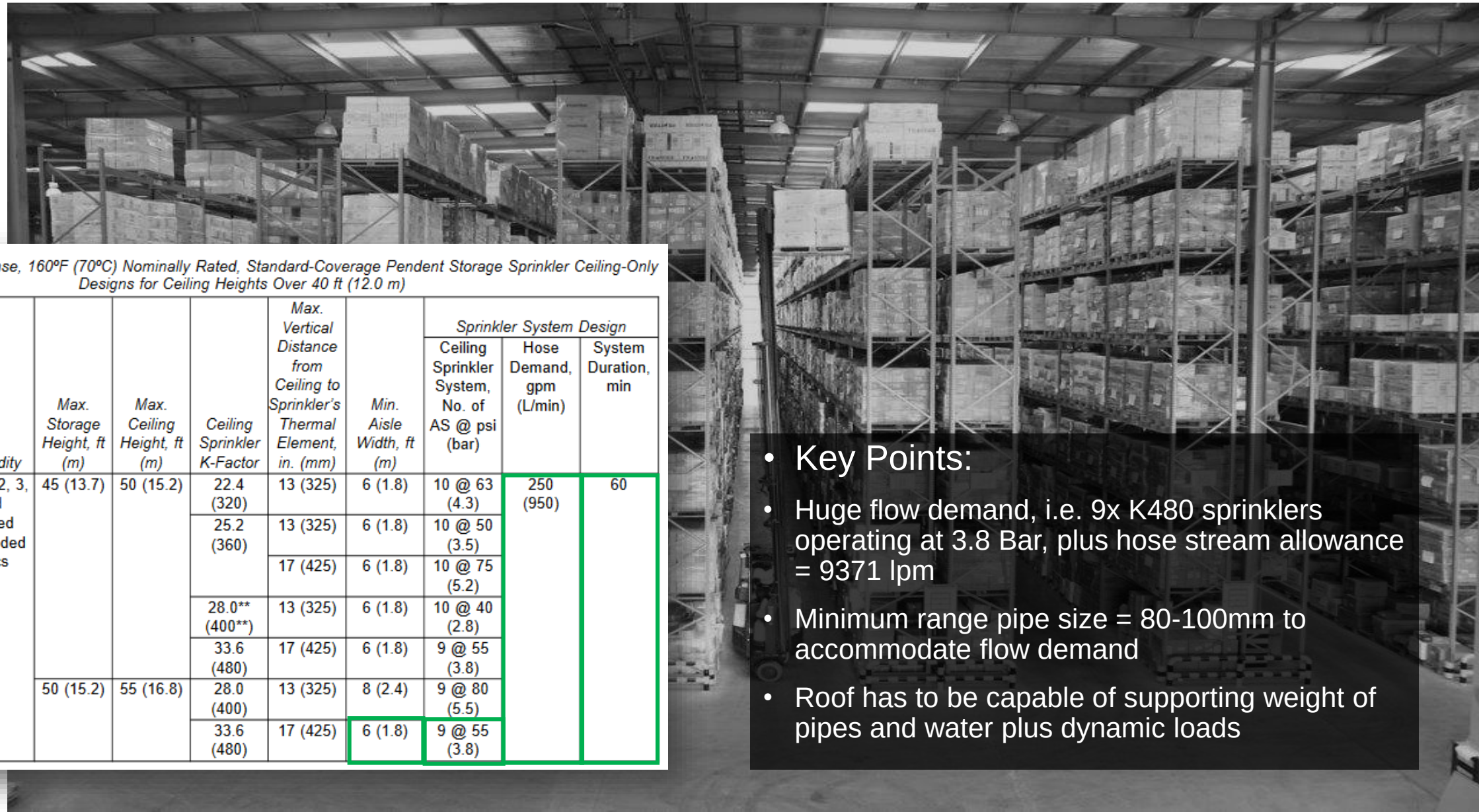



*Table 17b. Quick-Response, 160ºF (70ºC) Nominally Rated, Standard-Coverage Pendent Storage Sprinkler Ceiling-Only Designs for Ceiling Heights Over 40 ft (12.0 m)*

| *Storage Arrangement* | *Commodity* | *Max. Storage Height, ft (m)* | *Max. Ceiling Height, ft (m)* | *Ceiling Sprinkler K-Factor* | *Max. Vertical Distance from Ceiling to Sprinkler's Thermal Element, in. (mm)* | *Min. Aisle Width, ft (m)* | *Sprinkler System Design* | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Ceiling Sprinkler System, No. of AS @ psi (bar) | Hose Demand, gpm (L/min) | System Duration, min |
| Solid-Piled, Palletized, Bin-Box, Shelf, and Open-Frame Racks* | Class 1, 2, 3, 4 and Cartoned Unexpanded Plastics | 45 (13.7) | 50 (15.2) | 22.4 (320) | 13 (325) | 6 (1.8) | 10 @ 63 (4.3) | 250 (950) | 60 |
| | | | | 25.2 (360) | 13 (325) | 6 (1.8) | 10 @ 50 (3.5) | | |
| | | | | | 17 (425) | 6 (1.8) | 10 @ 75 (5.2) | | |
| | | | | 28.0** (400**) | 13 (325) | 6 (1.8) | 10 @ 40 (2.8) | | |
| | | | | 33.6 (480) | 17 (425) | 6 (1.8) | 9 @ 55 (3.8) | | |
| | | 50 (15.2) | 55 (16.8) | 28.0 (400) | 13 (325) | 8 (2.4) | 9 @ 80 (5.5) | | |
| | | | | 33.6 (480) | 17 (425) | 6 (1.8) | 9 @ 55 (3.8) | | |

# Ceiling Only Options – What's the Limit?

## *FMD 8-9 Table 17b*



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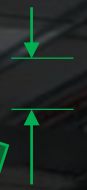
| | | 50 (15.2) | 55 (16.8) | 28.0 (400) | 13 (325) | 8 (2.4) | 9 @ 80 (5.5) | | |
| | | | | 33.6 (480) | 17 (425) | 6 (1.8) | 9 @ 55 (3.8) | | |

- Key Points:
- Huge flow demand, i.e. 9x K480 sprinklers operating at 3.8 Bar, plus hose stream allowance = 9371 lpm
- Minimum range pipe size = 80-100mm to accommodate flow demand
- Roof has to be capable of supporting weight of pipes and water plus dynamic loads

## Key Point:

- With some types of roof construction, it will always be a challenge to keep the maximum vertical distance from ceiling to sprinkler's thermal element to less than the required 325 – 425mm



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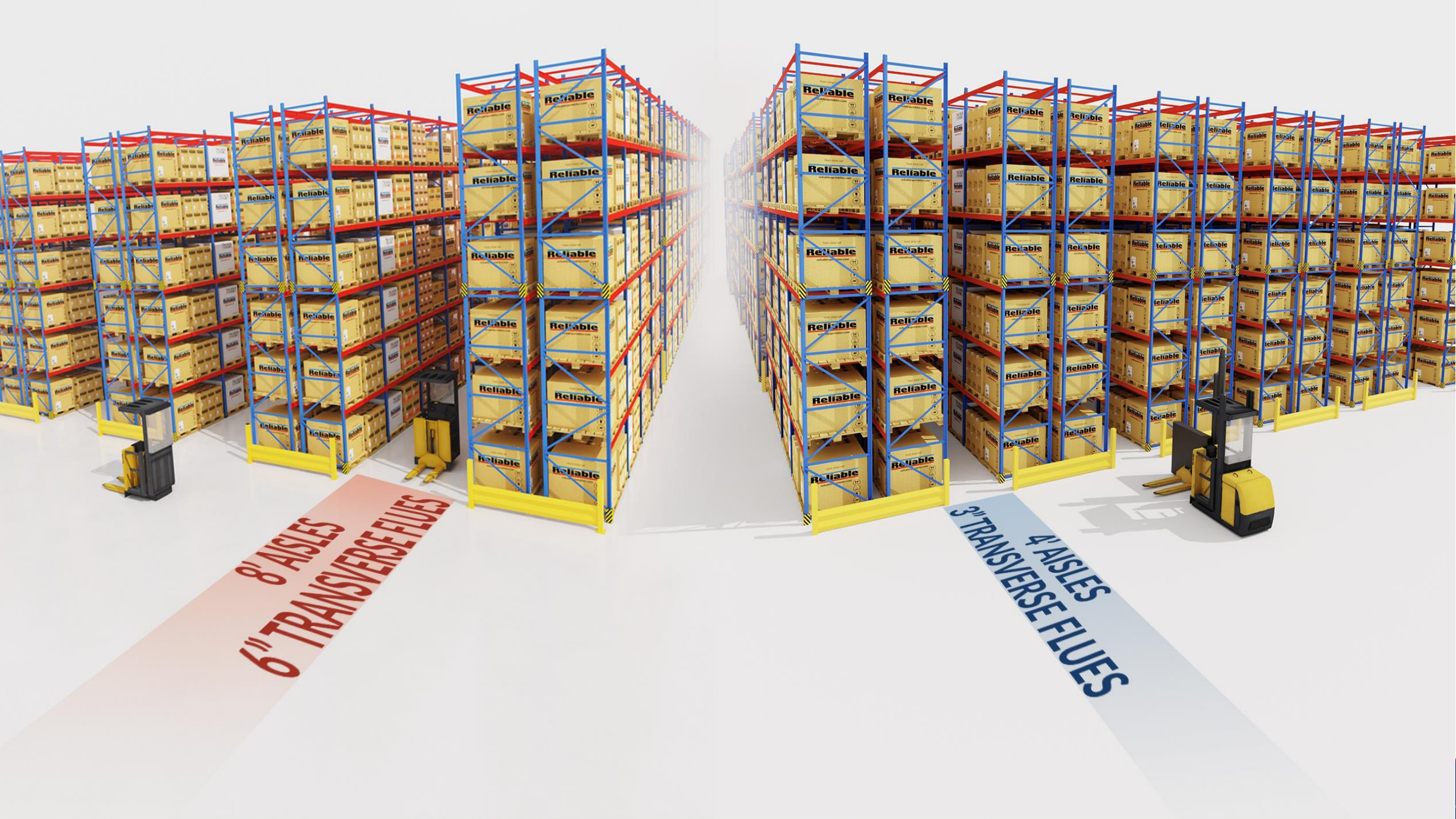
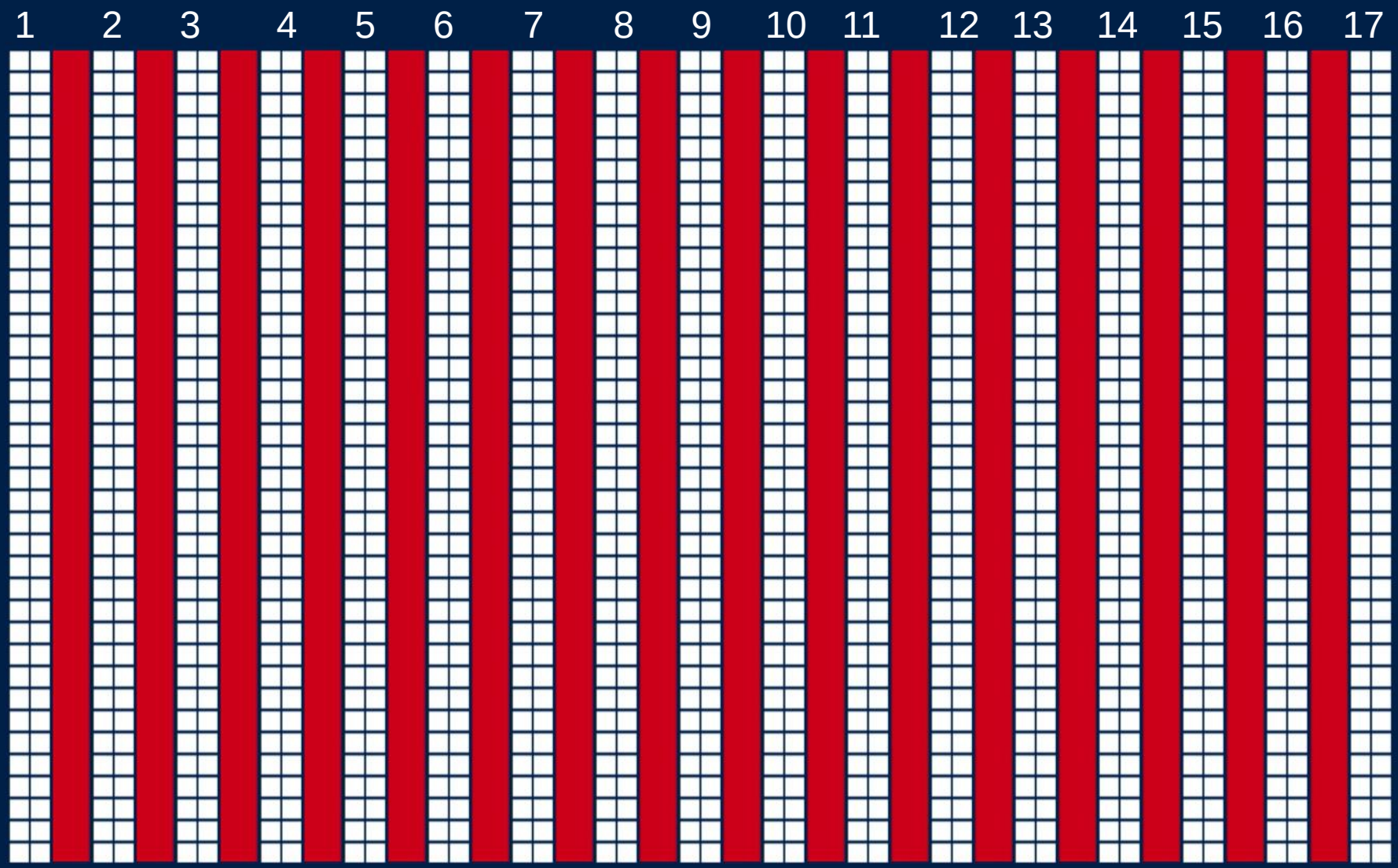
# Ceiling Only Options – What Next?

***If we could narrow aisles, could we could store more with lower ceilings?***

# Ceiling Only Options – What Next?

***If we could narrow flues, could we could store more with lower ceilings?***


8' AISLES
6" TRANSVERSE FLUES
4' AISLES
3" TRANSVERSE FLUES

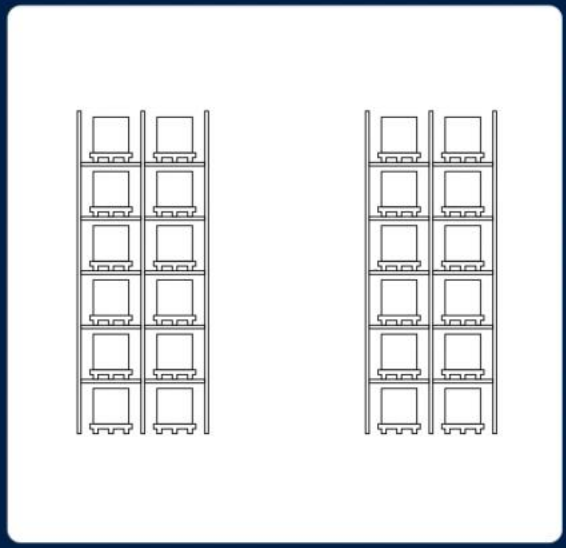



## STORAGE CAPACITY

**18.5K**
METRES³

**2.4**
METRE AISLES

**150**
MILLIMETRE FLUES



NEW RELIABLE MODEL N28T3 ESFR PENDENT SPRINKLER

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23

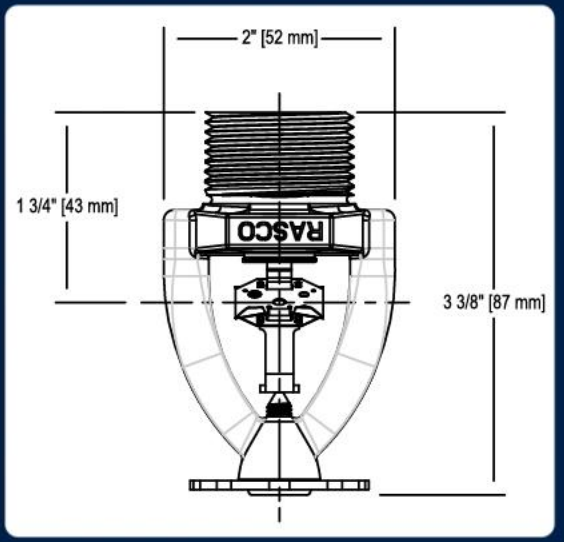
## STORAGE CAPACITY

**34.0K**

METRES³

**1.2**
METRE AISLES

**75**
MILLIMETRE FLUES



# Evolution of UL CMSA Sprinklers for 14.6m Ceiling / 13.1m Storage

***From the Reliable HL22 to the Reliable N28T3***

| | Reliable | Manuf. A | Manuf. B | Manuf. C | Reliable | Reliable |
|---|---|---|---|---|---|---|
| Model | HL22 | | | | N28T6 | |
| K-Factor | 320 | 360 | 360 | 360 | 400 | |
| Temperature | 74º / 100º | 74º / 100º | 100º | 74º / 100º | 74º / 100º | |
| Commodity | Class I-IV, CUP | Class I-IV, CUP | Class I-IV, CUP | Class I-IV, CUP | Class I-IV, CUP | |
| Palletized | √ | √ | √ | √ | √ | |
| Solid Pile | √ | √ | √ | √ | √ | |
| Single-Row Racks | √ | √ | √ | √ | √ | |
| Double-Row Racks | √ | √ | √ | √ | √ | |
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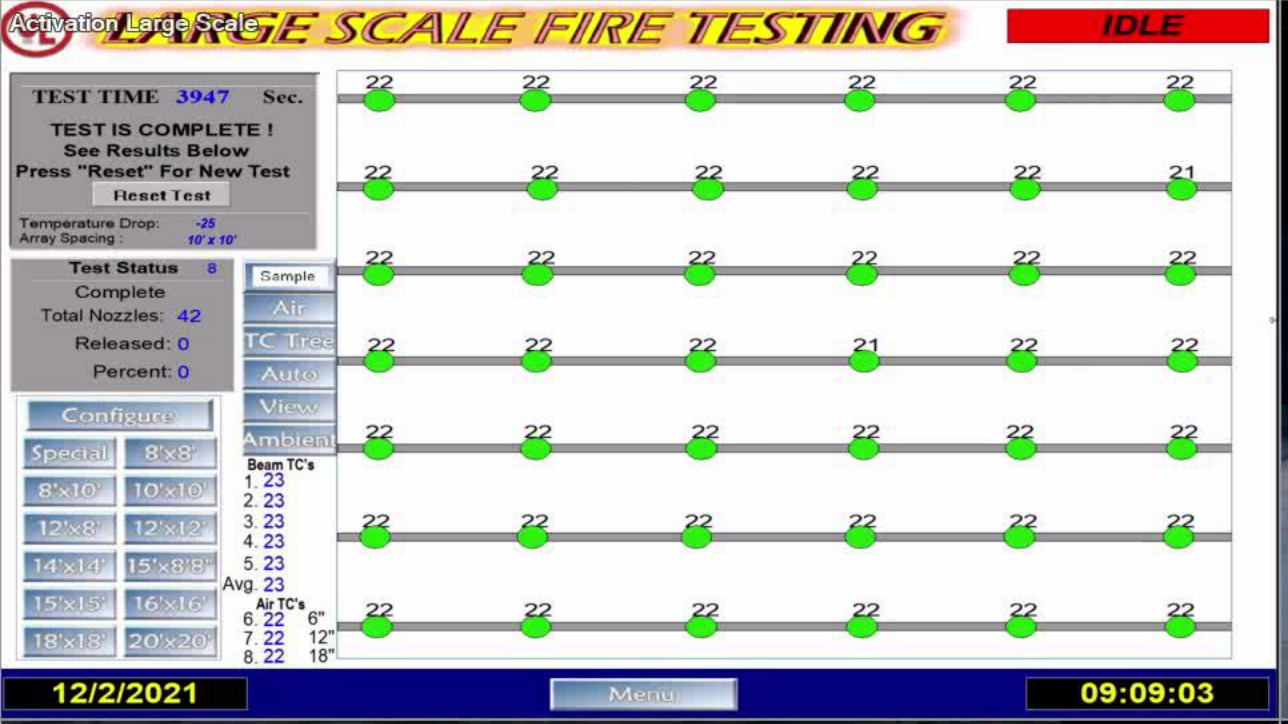
| Portable Racks | | | √ | | √ | |
| Aisle Width | 2.4m | 1.5m | 1.2m | 1.5m | 1.2m | |
| Flues | 150mm | 150mm | 150mm | 150mm | 150mm | |
| Design psi | 3.8 Bar | 3.1 Bar | 3.1 Bar | 3.1 Bar | 2.4 Bar | |
| Total Flow | 7486 lpm | 7606 lpm | 7606 lpm | 7606 lpm | 7436 lpm | |

*Minimum 3” transverse flue spaces permitted in single-row and double-row racks (longitudinal 150mm, per NFPA 13)






# New Solutions in Sprinkler Protection:

- **Lithium-Ion Battery Production Facilities**

# Li-Ion Cell Manufacturing

*The price of batteries declined by 97% in three decades…*

Key Point:

- *'In 2023, the price of lithium-ion battery packs has dropped to a record low of $139/kWh…'* Bloomberg (achieved by economy of scale)



# The Top 10 Countries for EV Battery Production

**How to read this**

*Rank and country*
*2021 capacity*
*(Gigawatt-hours)*

**2. U.S.**
**44 GWh**

*GWh size*

Volkswagen plans to build 6 factories in Europe by 2030 with a combined annual capacity of 240 GWh.

**8.** Sweden
**4 GWh**

**7.** Germany
**11 GWh**

**9.** UK
**2 GWh**

**4.** Poland
**22 GWh**

**3.**Hungary
**28 GWh**

**2.** U.S.
**44 GWh**

**1.** China
**558 GWh**

**6.** Japan **17 GWh**

**5.** South Korea **18 GWh**

**10.** Australia **1 GWh**

Nevada hosts the world's largest megafactory in the Panasonic-Tesla Gigafactory 1, with 37 GWh of annual capacity.

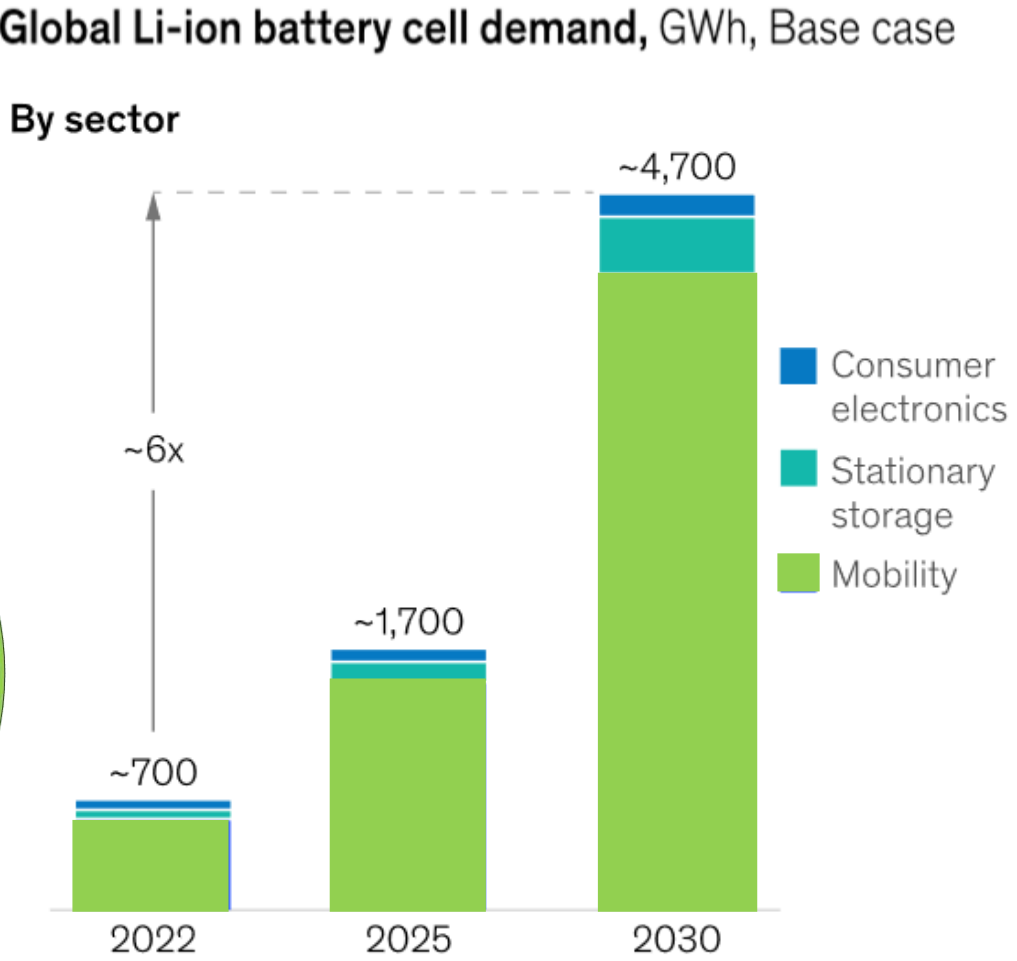
**4 of the 10** largest battery manufacturers are headquartered in China.

*Source: S&P Global Market Intelligence (February, 2021)*

# What's Driving Demand?

*Li-ion battery demand is expected to grow by about 33% annually to reach around 4,700 Giga-watt Hours by 2030…*

- Key Point:
- Transport is by far the biggest sector in Lithium-Ion battery manufacturing



# What Are The Risk Factors?…

*Li-ion battery manufacturing technology is evolving continuously…*

## Positives

- Consequences of any disruption are well known and so drive-up standards for how manufacturers manage their sites
- These tend to be very well managed risks
- Loss history in large manufacturing facilities has been low to date

## Negatives

- Perceptions that fire protection standards and products have not kept pace with Li-Ion manufacturing technology
- Potential for huge Foreseeable Maximum Loss Scenarios for:
  - Property
  - Business Interruption
  - The Environment
- Insurance Availability – Who has the capacity / appetite?
  - Underwriters expect robust fire emergency protection plans in place
  - Low-appetite for proto-typical risks in emerging technologies = higher captive / excess

# What Are The Risk Factors?…

*Stages in Li-ion battery manufacturing…*

- Formation & Aging - *Thermal runaway is most probable during these steps:*
  - Cells contain flammable electrolyte
  - Cells charged and contain energy
  - Cells typically stored for 2 weeks to stabilize chemically
  - Newly charged cells are more dangerous than previously charged cells at this point

**Key Point:**

- Every severe fire that has damaged a battery manufacturing plant has started in the formation area


Schematic of LIB manufacturing processes (Source: Sciencedirect)

# What is a Lithium Ion-Battery?

Each format has its own unique advantages and drawbacks:

- Prismatic cells offer superior packing capacity
- Pouch cells are highly portable
- Cylindrical cells are reliable and easy to scale up for large manufacturing.

Cylindrical

Prismatic

Pouch

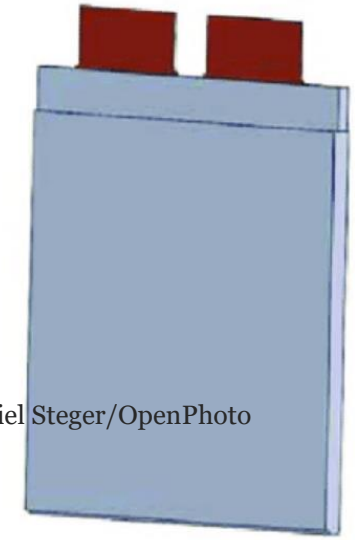
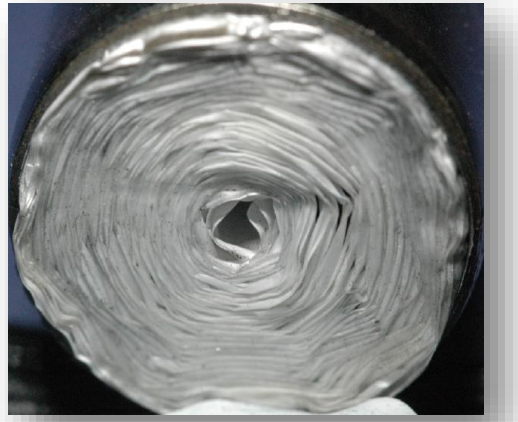


Image: Daniel Steger/OpenPhoto

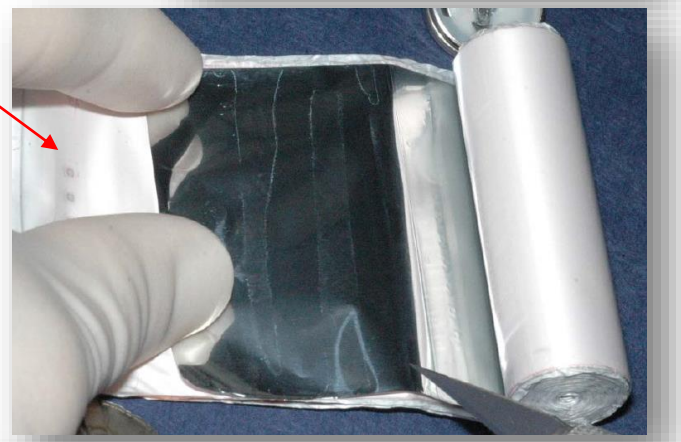
Key Points:

- 3 main types: Cylindrical, Prismatic, Pouch
- Cylindrical is the highest hazard - they can withstand high internal pressure without cases deforming but contents are discharged at high pressure when casings eventually split

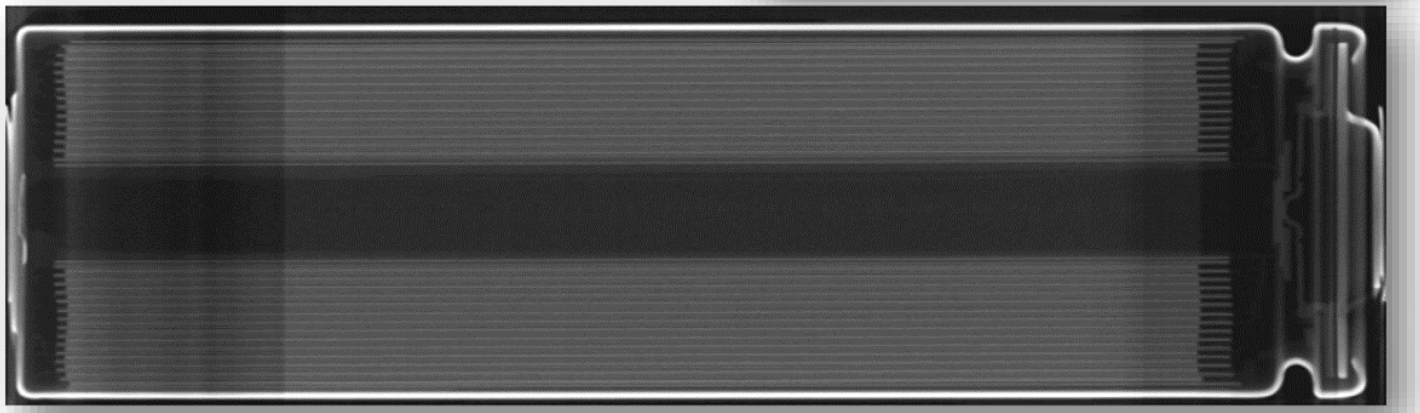
# What's Inside a Lithium Ion-Battery?



- Cells have three key elements: Electrodes, electrolyte and separator:
  - Electrodes store the lithium
  - The electrolyte carries the lithium ions between electrodes
  - The separator keeps the positive electrode from coming into contact with the negative electrode

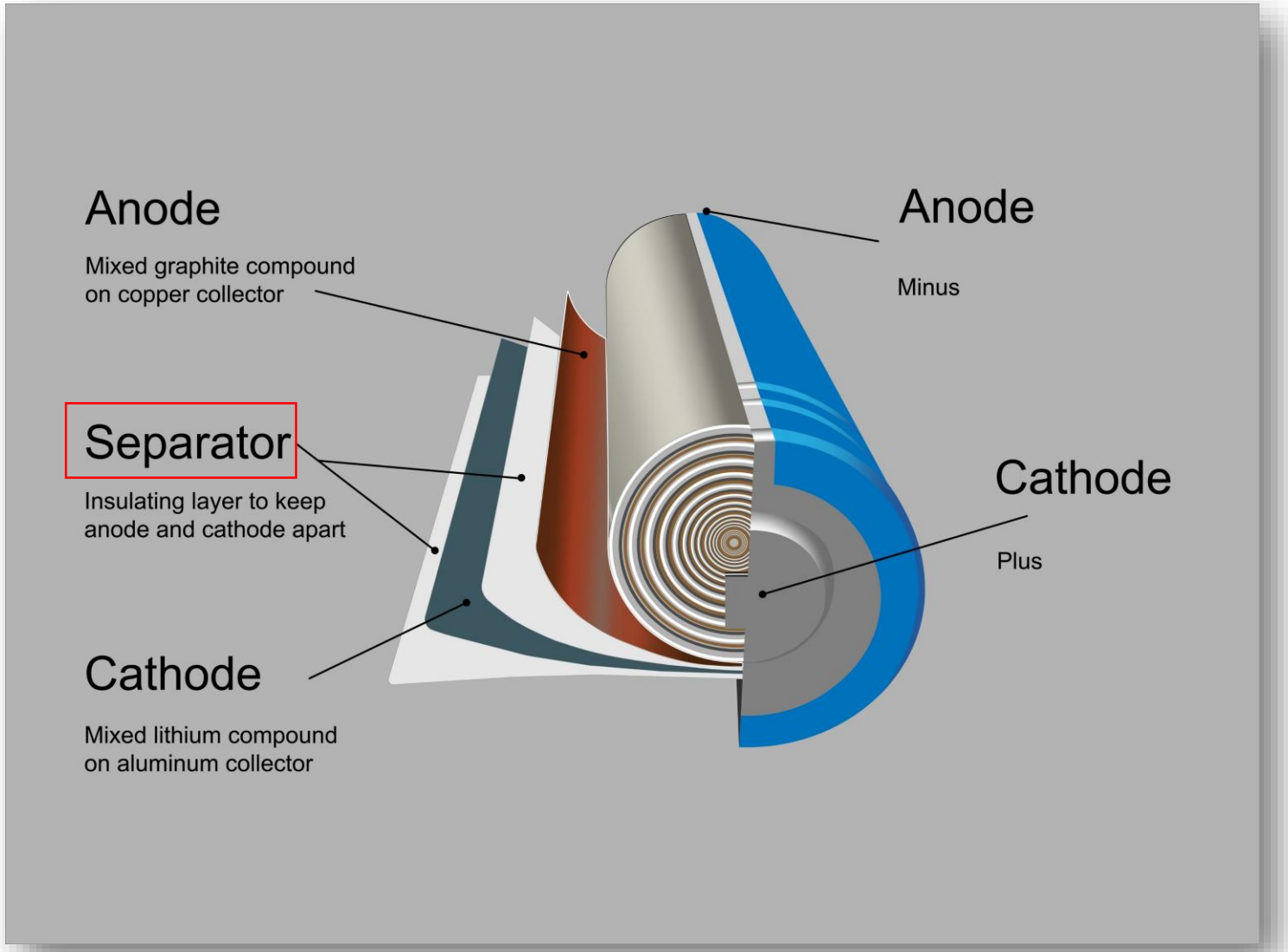


- Energy, in the form of electricity, is discharged from the battery cell when lithium ions flow from the negative electrode, or anode, to the positive electrode, or cathode. When the cell is charging, those ions flow in the opposite direction, from cathode to anode.



# What's Inside a Lithium Ion-Battery?

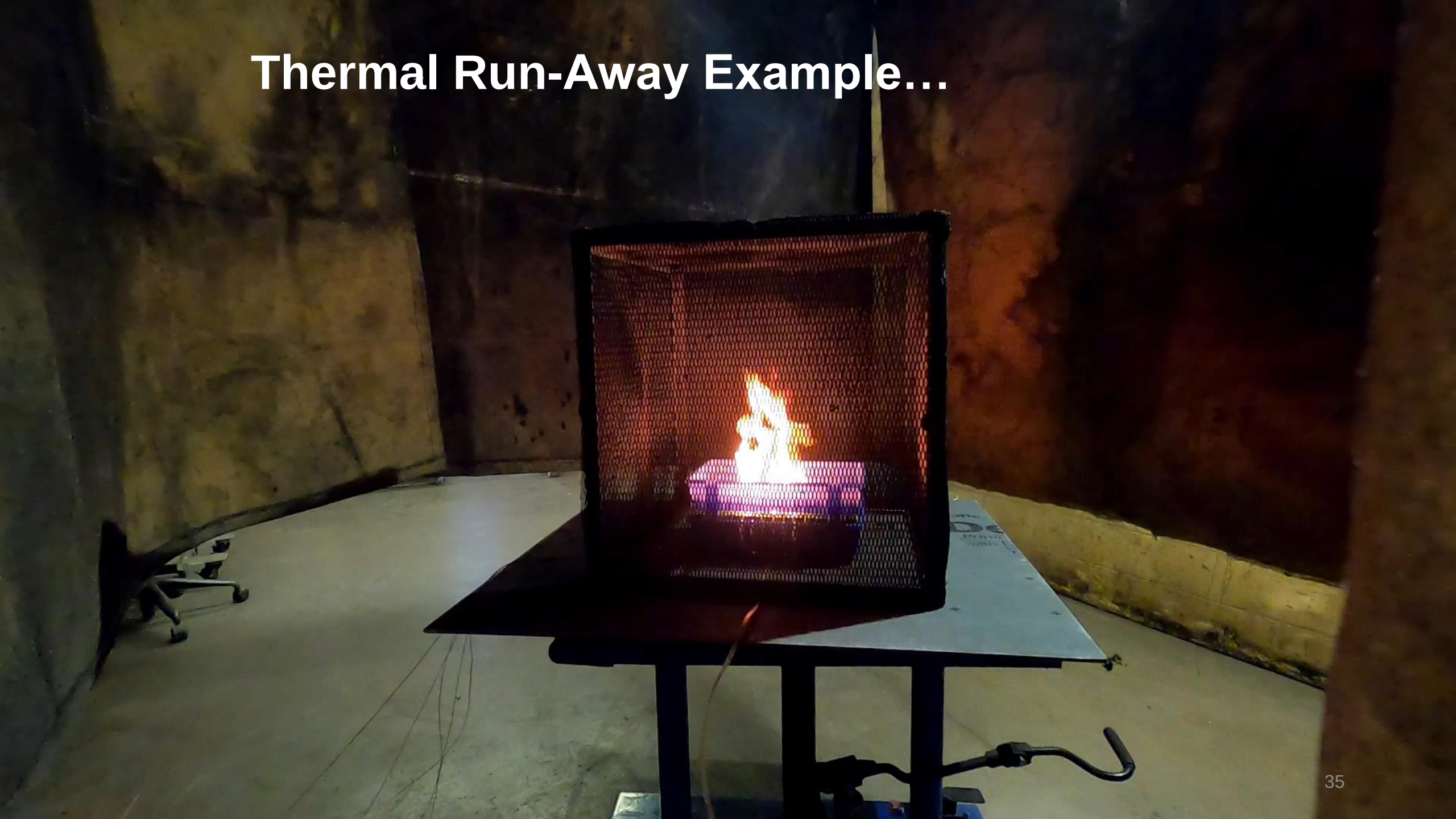
Cylindrical Cell




## Key Point:

- Impact damage and shock can damage the separation layer, resulting in short circuits and thermal runaway, which are the main cause of battery fires

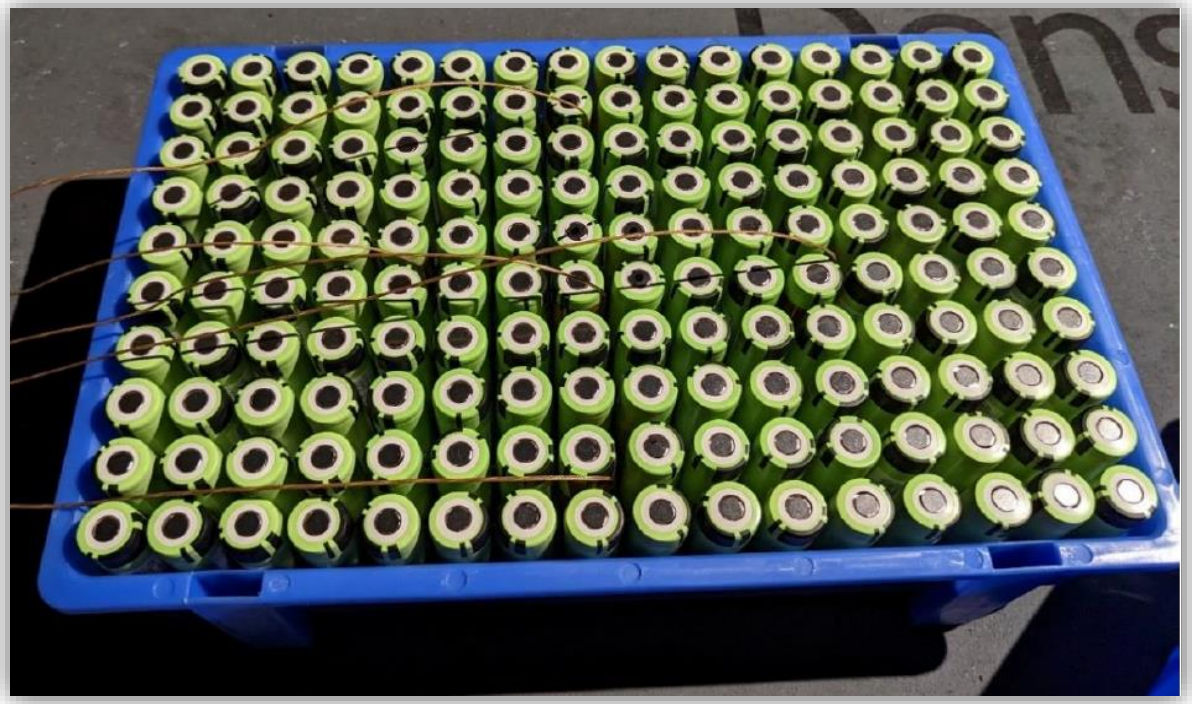
# Thermal Run-Away Example…



# Thermal Runaway Example – Free Burn Result:

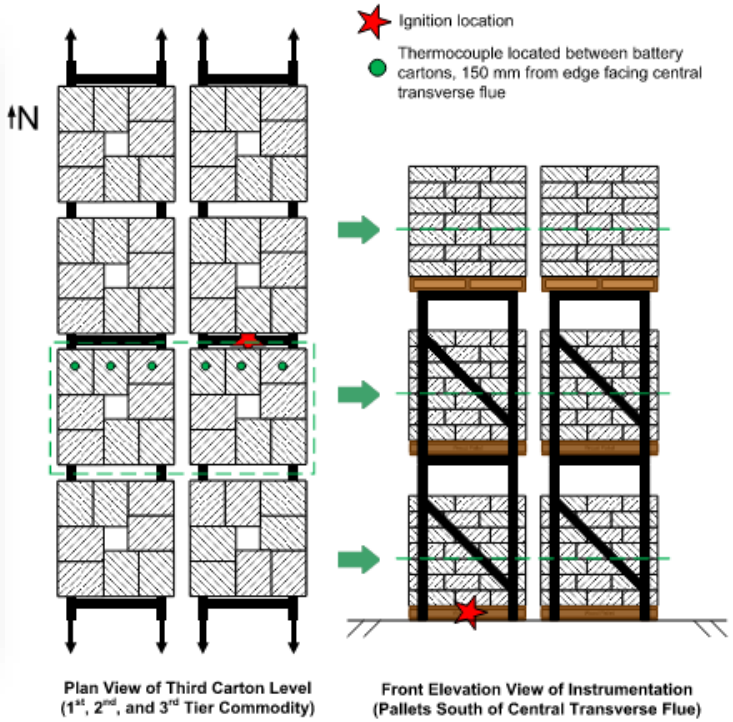
Key Point:

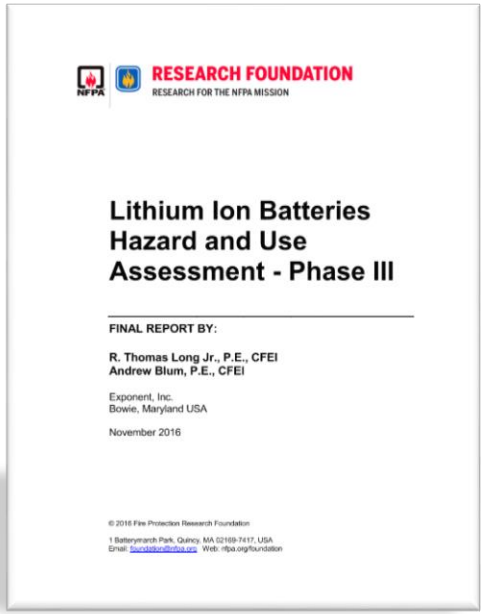
- This test was with 160 Cylindrical Cells at 100% charge – Electric Powered Cars typically have 6-8000 cells



# Fire Protection Options:

*Previous Research…*



RESEARCH FOUNDATION
RESEARCH FOR THE NFPA MISSION

**Lithium Ion Batteries Hazard and Use Assessment - Phase III**

FINAL REPORT BY:

R. Thomas Long Jr., P.E., CFEI
Andrew Blum, P.E., CFEI

Exponent, Inc.
Bowie, Maryland USA

November 2016

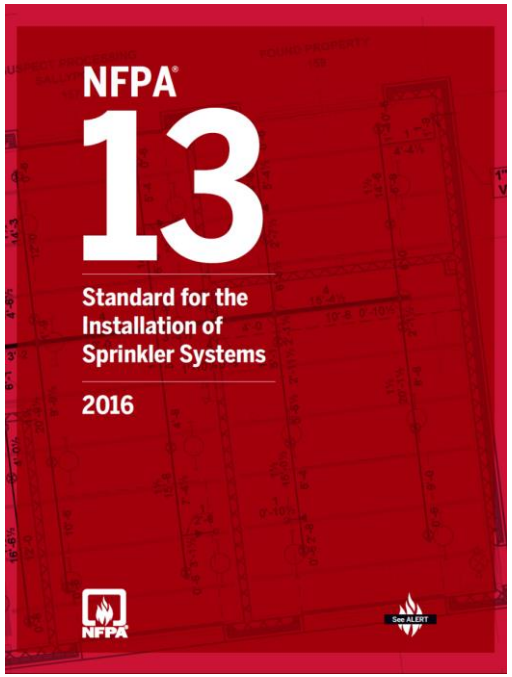

RESEARCH TECHNICAL REPORT

*Development of Protection Recommendations for Li-ion Battery Bulk Storage: Sprinklered Fire Test*

FM Global

# Fire Protection Options:

*NFPA13?…*





**A.5.6**

**Table A.5.6 provides examples of commodities not addressed by the classifications in Section 5.6. The commodities listed in Table A.5.6 are outside the scope of NFPA 13 protection.**

**Table A.5.6 Examples of Commodities Not Addressed by Classifications in Section 5.6**

Ammunition Components
- Bulk primers and powder

Batteries
- Lithium and other similar exotic metals
- Lithium-ion and other rechargeable batteries that contain combustible electrolyte

Boat Storage
- Stored on racks

Boxes, Crates
- Empty, wood slatted*

Carpet Rolls

Combustible Metals — unless specifically identified otherwise

Compressed or Liquefied Flammable Gases (i.e., filled propane cylinders) — unless specifically identified otherwise

Explosives
- Blasting primers and similar items

## Key Point:

- Lithium-Ion batteries are currently outside the scope of NFPA13

# Fire Protection Options:

*Factory Mutual Datasheet 8-1…*

## With K320 Ceiling Level Only

| Ceiling <12m & <60% Charge | FMD 8-1 (01/2023) |
|---|---|
| Mode of Operation | Control/Suppression |
| Max Storage Height | 4.5m |
| Commodity | Wood crate, metal, encased or corrugated carton with cellulosic and/or unexpanded plastic internal packaging only |
| AMNOSO* | 12 |
| Min. Design Pressure | 2.4 Bar |
| (K320 Equivalent) Flow / Sprinkler | 582 L/min |
| Hose Stream | 946 L/Min |
| Duration | 120 minutes |
| Total Discharge | 951,600 Litres |

*Assumed Maximum Number Of Sprinklers Operating

## With K115 or K160 In-Rack

| Ceiling >12m & >60% Charge | FMD 8-1 (01/2023) |
|---|---|
| Mode of Operation | Control / Suppression |
| Independent of Roof | Yes |
| Orientation | Pendent |
| Temperature | 74°C |
| K Factor | 115 or 160 |
| Location | <150mm from face / <175mm below barrier |
| Minimum Clearance Below | 150mm |
| AMNOSO | 6 |
| Min. Design Flow / Sprinkler | 227 L/min |
| Hose Stream | 946 L/Min |
| Duration | 120 minutes |
| Total Discharge | 276,960 Litres |

# Fire Protection Options:

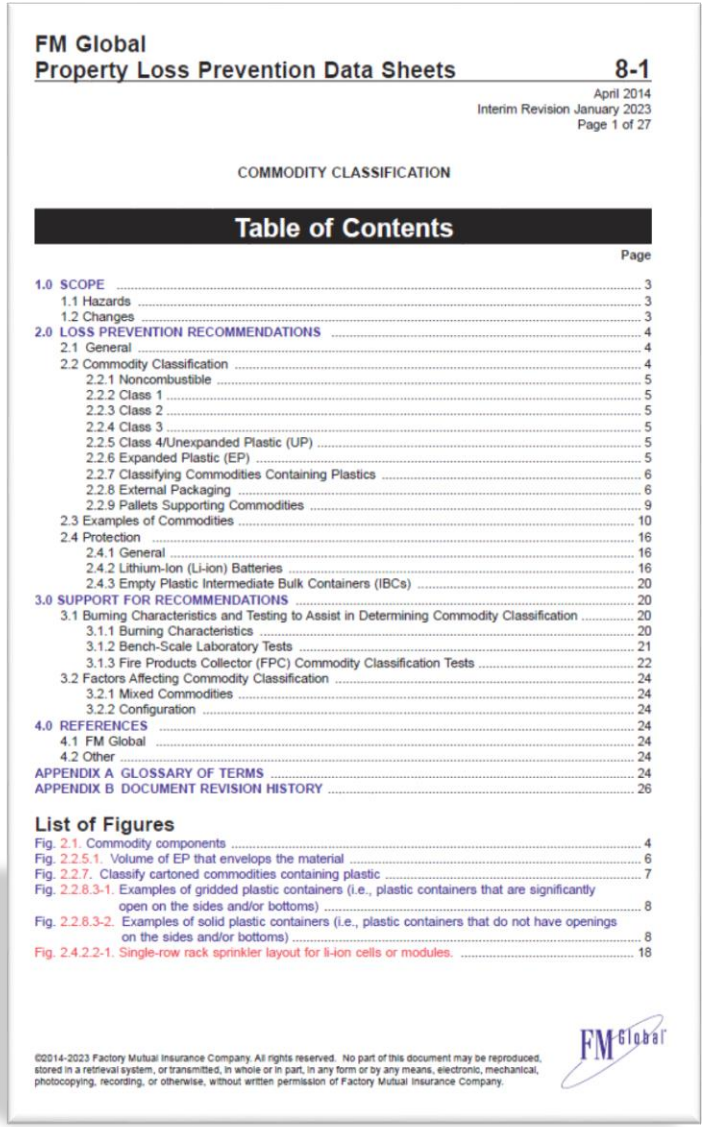
*Factory Mutual Datasheets?*

FMD 8-1 has a scheme to protect new li-ion cells and modules stored in open-frame rack, solid-pile or palletized storage arrangements per Table 2.4.2.1. **– however, this scheme also requires the following to be complied with:**

- 2.4.2.4 **Develop a pre-incident plan with the fire service in accordance with Data Sheet 10-1**, Pre-Incident and Emergency Response Planning. The plan should include manual fire protection methods to be employed and a designated location outside of the facility to which damaged and impacted cells can be moved

- 2.4.2.5 **Develop a post-incident recovery plan** that addresses the potential for reignition of li-ion batteries, as well as for the removal and disposal of any damaged or impacted cells, modules or products.

- 2.4.2.5.1 **A fire watch should be present** until all potentially damaged li-ion cells, modules or products have been removed from the area following a fire event.



FM Global
Property Loss Prevention Data Sheets 8-1

April 2014
Interim Revision January 2023
Page 1 of 27

COMMODITY CLASSIFICATION

Table of Contents



List of Figures





## Key Point:

- FMD 8-1 scheme is not just about the specification for the sprinkler protection, it also requires response plans…

# Reliable Model LB11

*UL Listed Specific Application – Class I-IV & Group A Plastics…*

Prepared by

UL Solutions

Project 4790720802 Ex454

for

Reliable Automatic Sprinkler Co., Inc.

Issued: May 19, 2023



## Key Points:

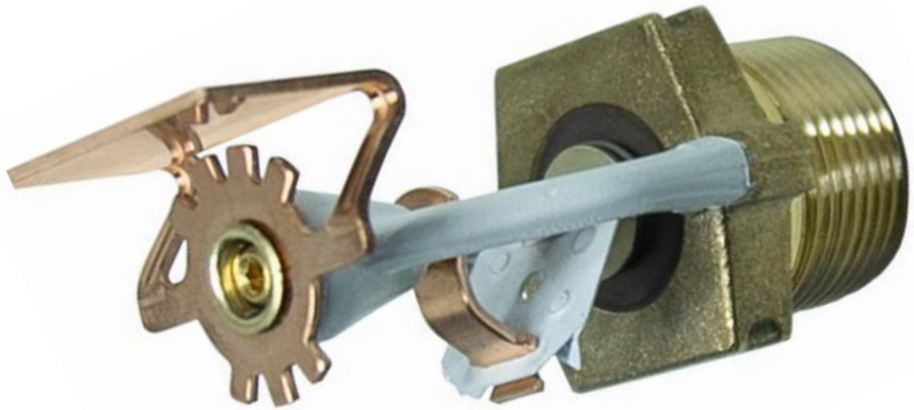
- UL Solutions are a global leader in applied safety science, for customers in more than 100 countries
- Reliable worked with Underwriter's Laboratories to develop a new test standard for Sidewall Storage sprinklers (UL199K)

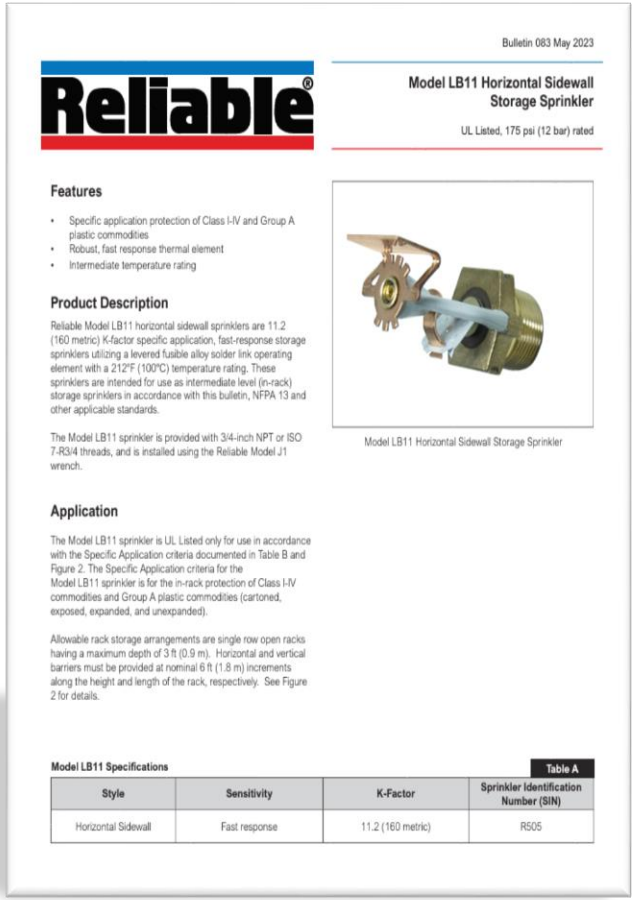
# Reliable Model LB11

*UL Listed Specific Application…*

## Key Point:

- The LB11 specific application  requires the storage configuration to match the test configuration, i.e. vertical & horizontal barriers





Bulletin 083 May 2023

Reliable®

Model LB11 Horizontal Sidewall Storage Sprinkler

UL Listed, 175 psi (12 bar) rated

**Features**

- Specific application protection of Class I-IV and Group A plastic commodities
- Robust, fast response thermal element
- Intermediate temperature rating

**Product Description**

Reliable Model LB11 horizontal sidewall sprinklers are 11.2 (160 metric) K-factor specific application, fast-response storage sprinklers utilizing a levered fusible alloy solder link operating element with a 212°F (100°C) temperature rating. These sprinklers are intended for use as intermediate level (in-rack) storage sprinklers in accordance with this bulletin, NFPA 13 and other applicable standards.

The Model LB11 sprinkler is provided with 3/4-inch NPT or ISO 7-R3/4 threads, and is installed using the Reliable Model J1 wrench.

Model LB11 Horizontal Sidewall Storage Sprinkler

**Application**

The Model LB11 sprinkler is UL Listed only for use in accordance with the Specific Application criteria documented in Table B and Figure 2. The Specific Application criteria for the Model LB11 sprinkler is for the in-rack protection of Class I-IV commodities and Group A plastic commodities (cartoned, exposed, expanded, and unexpanded).

Allowable rack storage arrangements are single row open racks having a maximum depth of 3 ft (0.9 m). Horizontal and vertical barriers must be provided at nominal 6 ft (1.8 m) increments along the height and length of the rack, respectively. See Figure 2 for details.

**Model LB11 Specifications** — Table A

| Style | Sensitivity | K-Factor | Sprinkler Identification Number (SIN) |
|---|---|---|---|
| Horizontal Sidewall | Fast response | 11.2 (160 metric) | R505 |

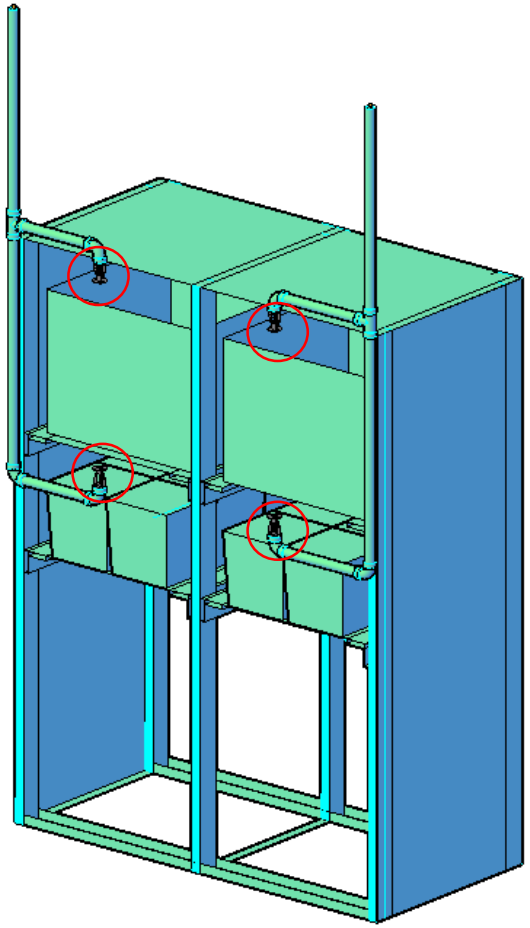
- **Listed for Category I-IV & Group A plastics**
- **Designed for protection of Lithium-ion Batteries in Manufacturing Facilities**

# Reliable Model LB11

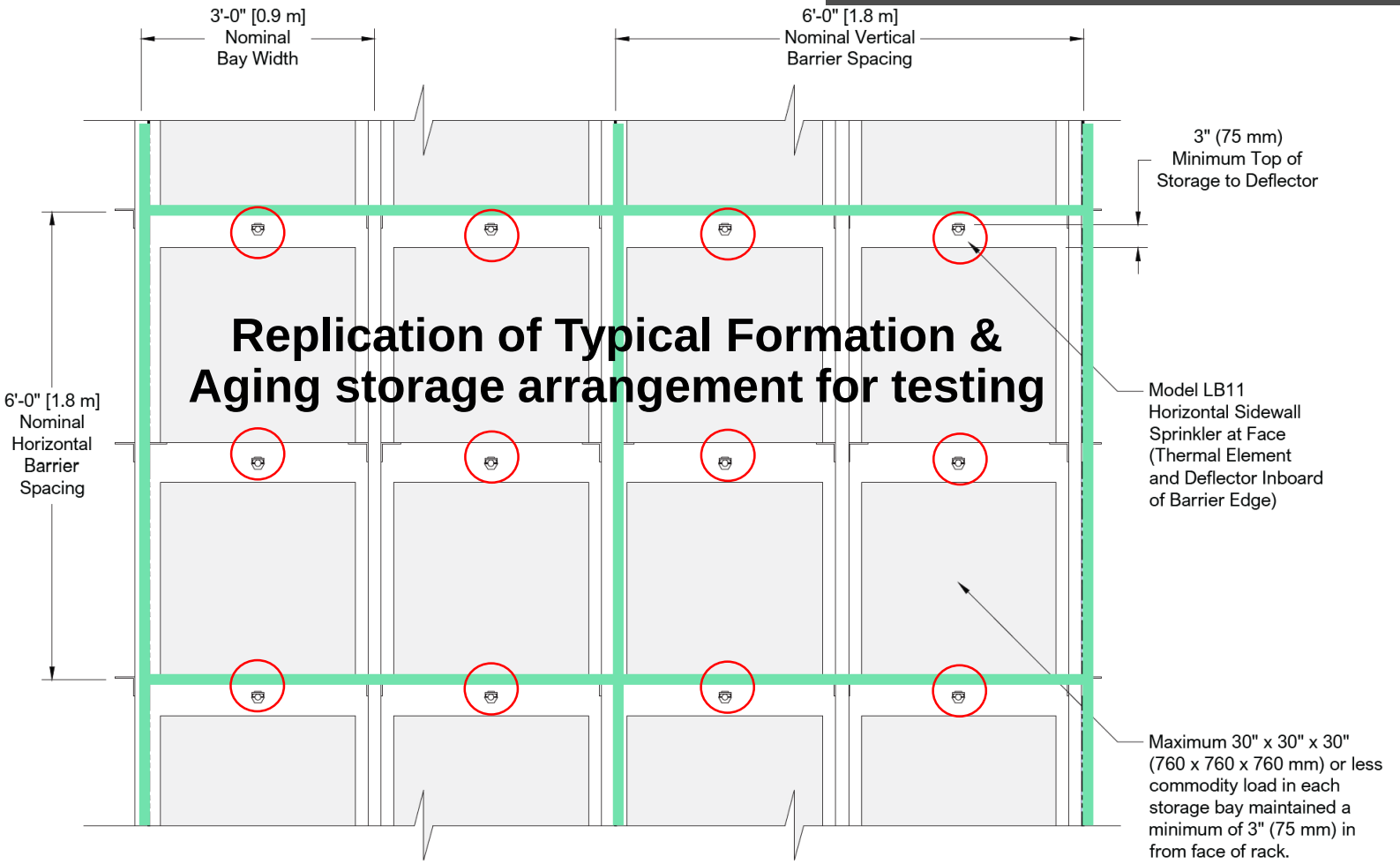
*Designed to protect Lithium-Ion battery manufacturing facilities……*

## Key Points:

- Battery manufacturers use various sprinkler orientations, but primarily to prevent rack collapse
- Located outside of the racking for ease of access

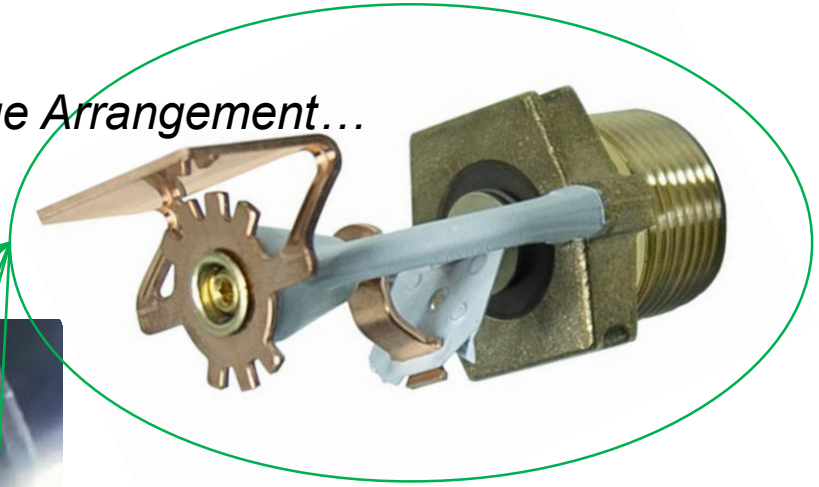


**Typical Formation & Aging storage rack**



# Reliable Model LB11

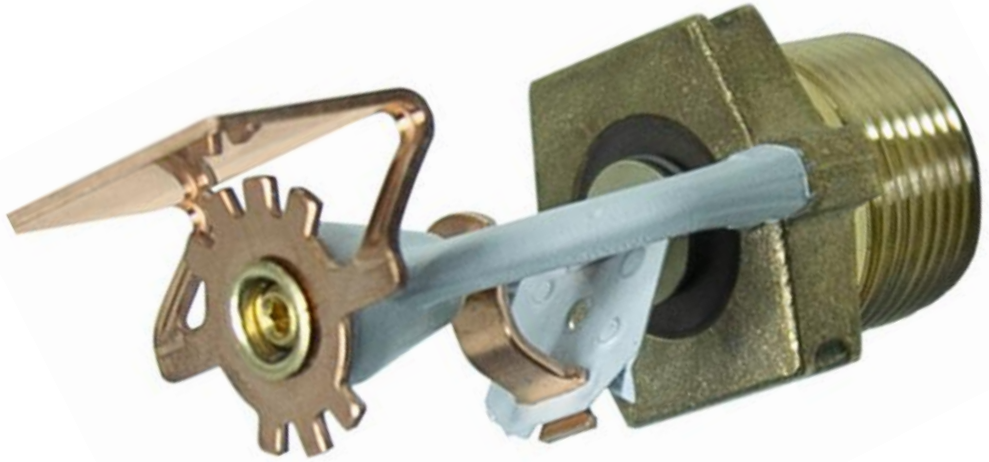
*Replicating Typical Aging & Formation Storage Arrangement…*

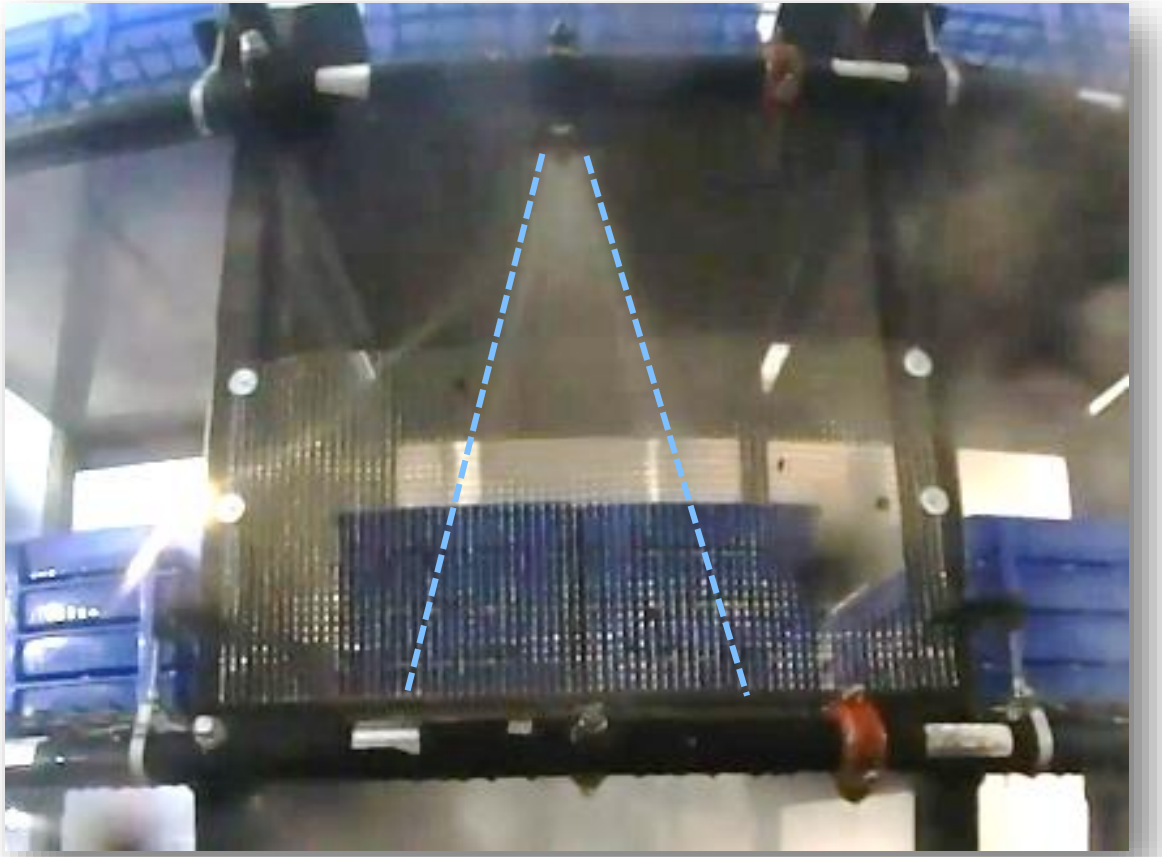


- The Model LB11 sprinkler was developed for protection of lithium-ion batteries in battery manufacturing facilities; specifically in formation, aging, and shipping/staging racks
- There is currently no standard test commodity for lithium-ion batteries. Thus, standard exposed expanded Group A plastic commodity was used in listing tests
- Further testing of the Model LB11 HSW sprinkler, was conducted with lithium-ion batteries – See Reliable **Technical Bulletin 084**

# Reliable Model LB11

*UL Listed Specific Application…*





- **Why Sidewall?**
- **Why K160?**

Key Points:

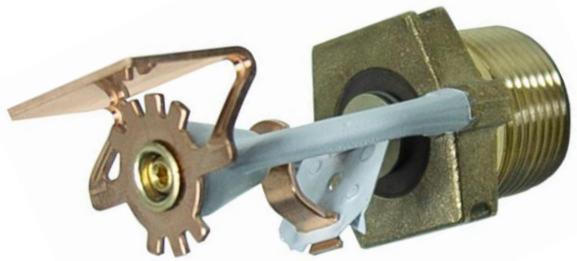
- A narrow, targeted spray pattern is achieved which is is very efficient, allowing for a high degree of targeted cooling with only modest quantities of water


# New Reliable LB11

## Design Information:

### Key Points:

- A narrow, targeted spray pattern is achieved which is is very efficient, allowing for a high degree of targeted cooling with only modest quantities of water



| | |
|---|---|
| Sprinkler System Design | Hydraulically calculate 4 sprinklers in the most remote area consisting of 2 sprinklers on 2 lines. Hydraulically calculate sprinklers at 60 gpm (225 L/min) each; not balanced with the ceiling-level sprinkler system; the ceiling-level sprinkler system must be designed in accordance with NFPA 13 to protect hazards and areas of the space not protected by the in-rack sprinkler system |
| Hose Stream Allowance, gpm (L/min) | 250 (950) |
| Water Supply Duration, minutes | 60 |
| Installation Requirements Relative to Horizontal and Vertical Barriers | Sprinklers immediately below horizontal barriers shall be not more than 3 in. (75mm) below the barrier<br>Four sprinklers shall be installed within each barriered area. All four sprinklers shall have deflectors and solder link located fully within the barriers. Maximum distance 20 in. (500 mm) from each vertical barrier to nearest sprinkler |


# New Reliable LB11

## Design Information:

**Key Points:**

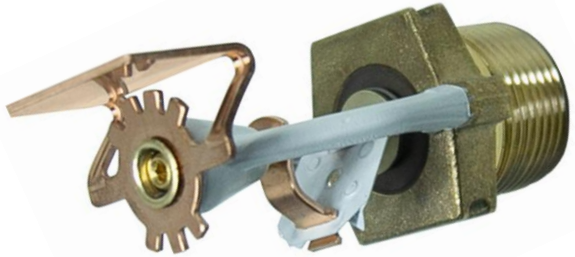
- A narrow, targeted spray pattern is achieved which is is very efficient, allowing for a high degree of targeted cooling with only modest quantities of water

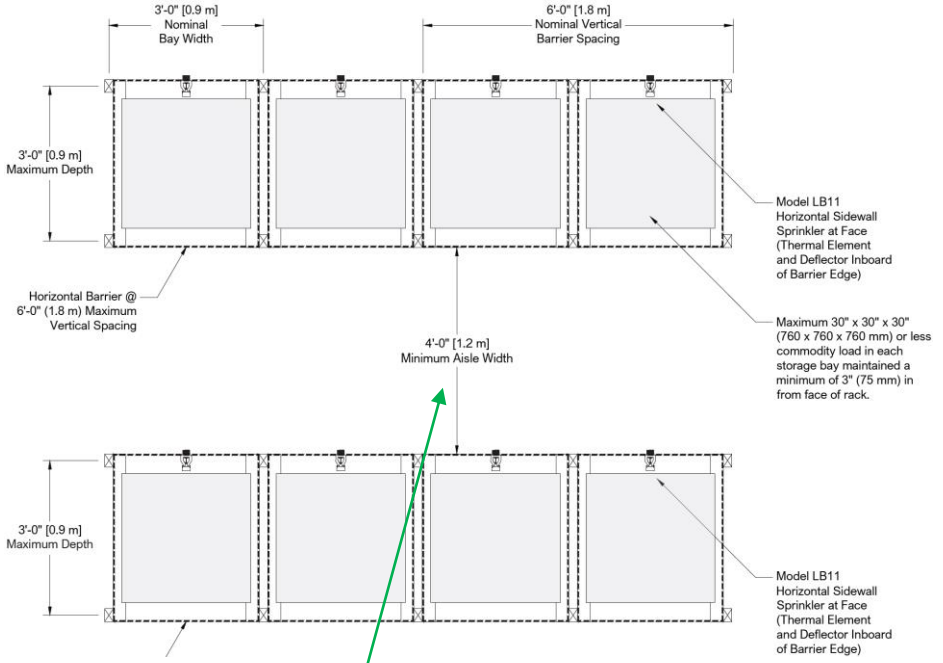
**Model LB11 Commodity Selection and Design Criteria** — **Table B**

| UL Specific Application Listing | |
|---|---|
| Model | LB11 |
| Sprinkler Identification Number (SIN) | R505 |
| Response Type | Fast |
| Orientation | Horizontal Sidewall |
| Nominal K-Factor, gpm/psi$^{1/2}$ (L/min/bar$^{1/2}$) | 11.2 (160) |
| Temperature Rating °F (°C) | 212 (100) |
| System Type | Wet, Single Interlock Preaction |
| Max. Sprinkler Spacing, ft (m) Lateral/Side-to-Side | 4 (1.2) |
| Min. Deflector to Top of Storage Distance, in (mm) | 3 (75) |
| Obstruction Criteria | Per NFPA 13 |
| Max. Ceiling Height, ft (m) | Unlimited |
| Max. Storage Height, ft (m) | Unlimited |

# New Reliable LB11

## Design Information:






## Key Points:

- As long as the aisle width is at least 1.2m, the fire will not jump from one rack to another

| | |
|---|---|
| Horizontal and vertical barrier construction | Horizontal and vertical barriers must be constructed of min. 3/8 in. (10 mm) plywood or particleboard, 22 gauge (0.7 mm) sheet metal, or equivalent. Vertical barriers must extend from a max. of 4 in. (100 mm) above the floor to the max. storage height. Horizontal barriers must extend from aisle to aisle. Horizontal barriers may have gaps of up to 2 in. (50 mm) at rack uprights only. |
| Min. Aisle Width, ft (m) | 4 (1.2) |
| Flue Spaces | NA |
| Commodity | Encapsulated and unencapsulated Class I - IV commodities, cartoned, exposed, expanded, and unexpanded Group A plastic commodities. |

# Reliable Model LB11

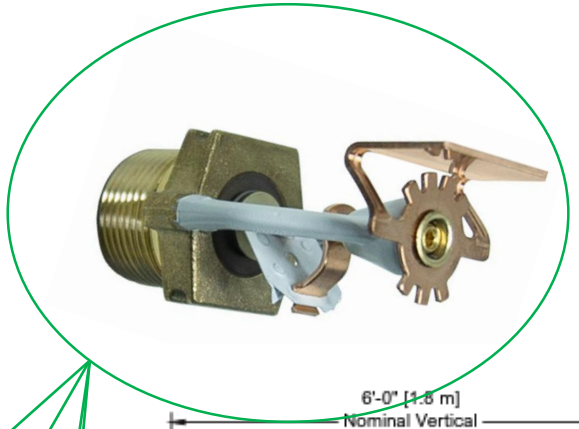
*UL Listed Specific Application – Class I-IV & Group A Plastics…*

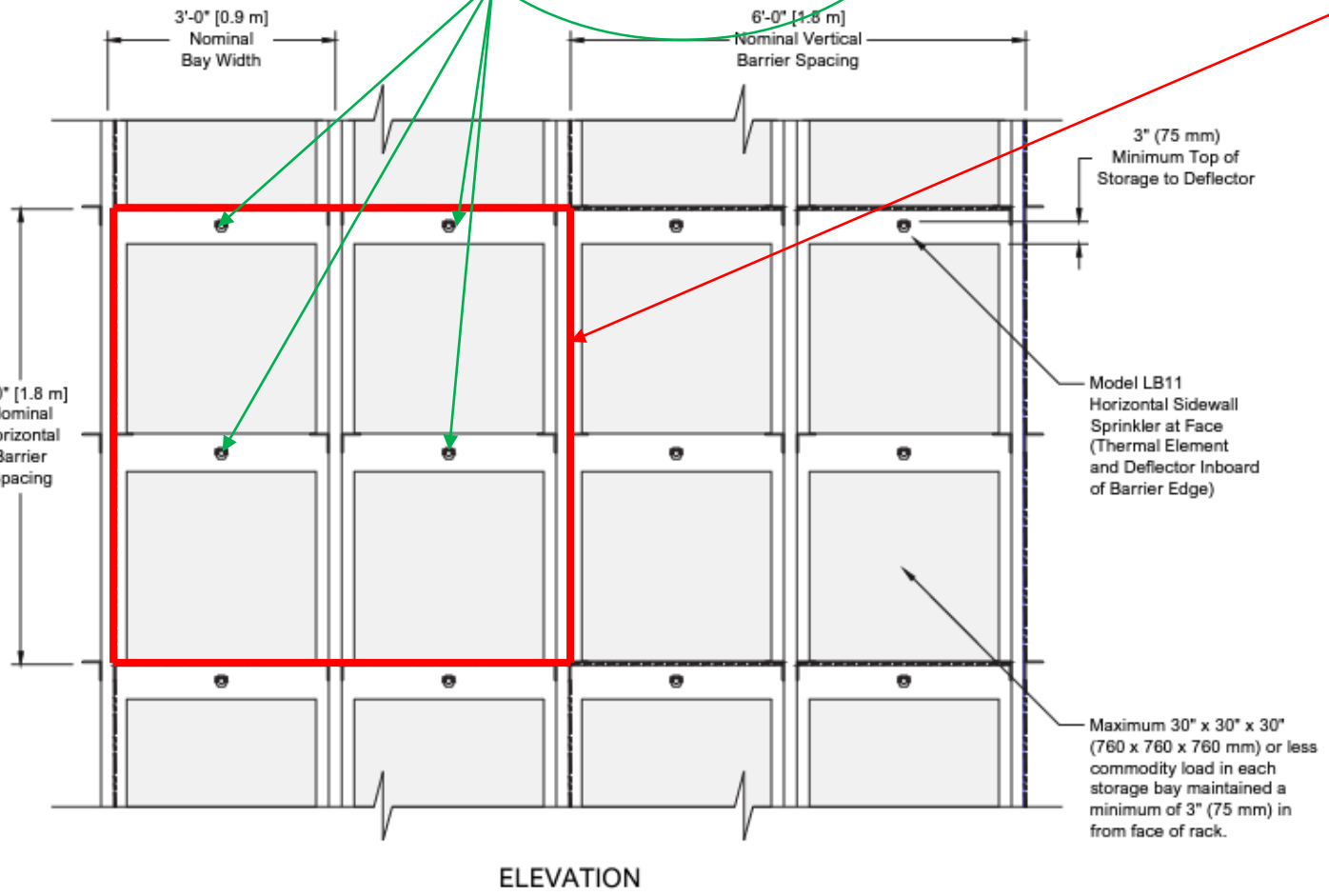

- Above: Full fuel loading in a storage location (24 full trays = 3840 cells)
- Left: Single Full Tray, Partially Full Tray and Component 18650 cell
- **All cylindrical cells charged to 100% State of Charge (SOC)**
- Trays = Group A unexpanded plastic

Key Point:

- Cylindrical cells at 100% charge, stored in polypropylene trays = the worst-case scenario

# New Reliable LB11 – Underwriter's Laboratory Fire Tests






ELEVATION

## Key Point:

- Typical storage arrangement with horizontal and vertical barriers @ 1.8m x 1.8m (shown in red)

*Prepared by*

*UL Solutions*

*Project 4790720802 Ex454*

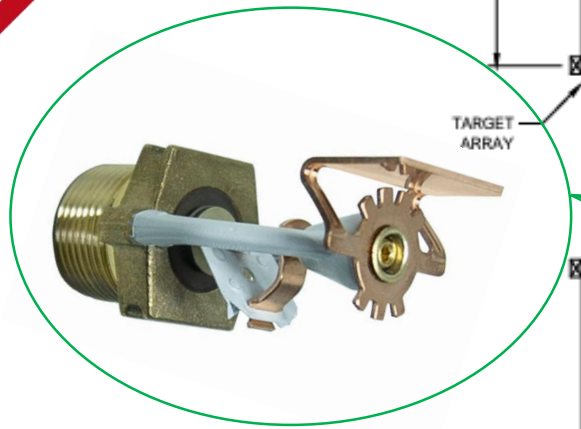
*for*

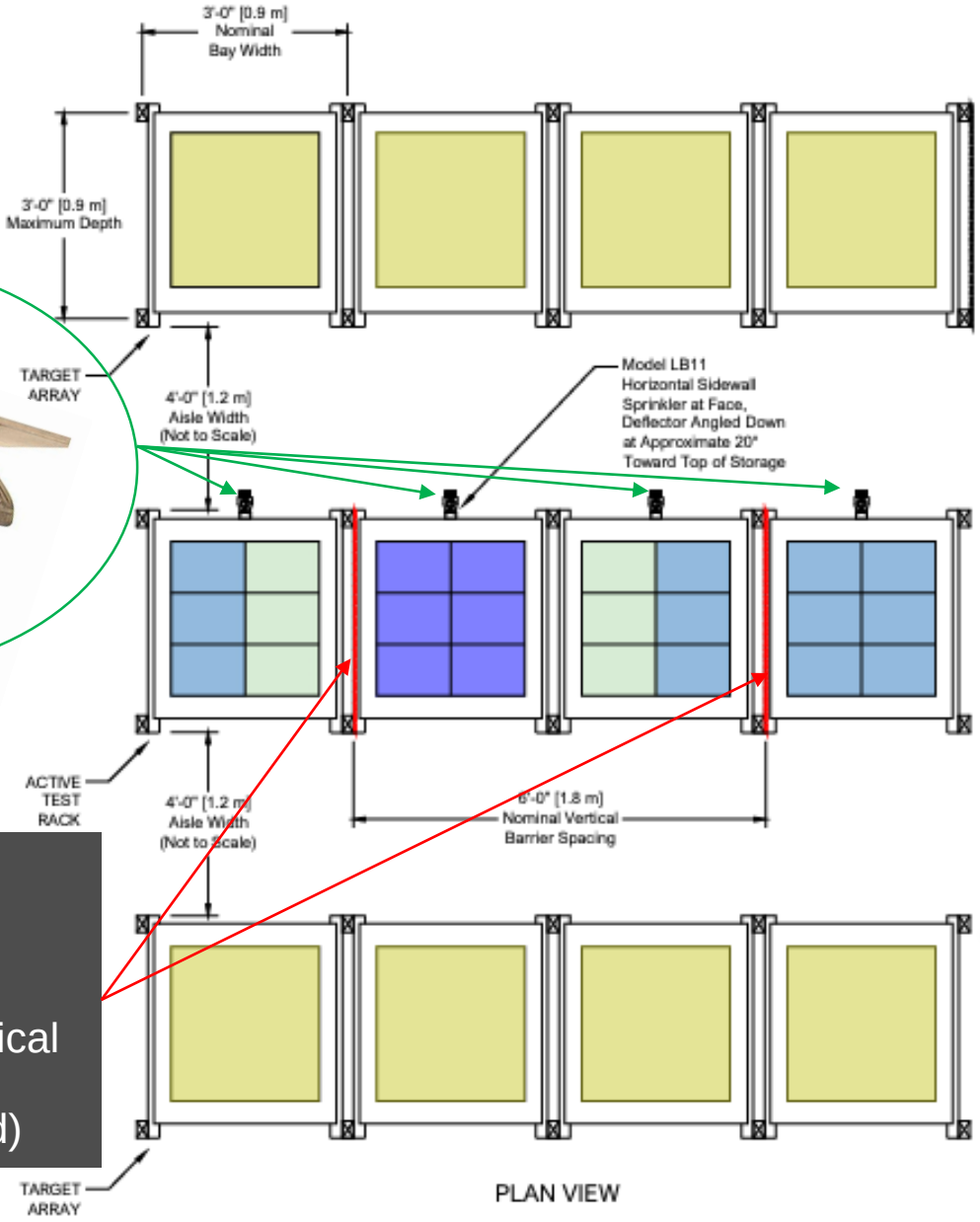
*Reliable Automatic Sprinkler Co., Inc.*

*Issued: May 19, 2023*



# New Reliable LB11 – Underwriter's Laboratory Fire Tests






## Key Point:

- Typical storage arrangement with horizontal and vertical barriers @ 1.8m x 1.8m (shown in red)

*Prepared by*

*UL Solutions*

*Project 4790720802 Ex454*

*for*

*Reliable Automatic Sprinkler Co., Inc.*

*Issued: May 19, 2023*




0:00
2:06
2:11
2:19
Reliable

# New Reliable LB11 – U.L. 199K Fire Testing:

Key Findings:

- Once thermal runaway and thermal runaway propagation occurred, the water discharged from two sprinklers slowed and eventually stopped the propagation of thermal runaway. However, flames extended across the aisle and through the north target array for a limited period of time

- While the cardboard face of the cartoned Group A plastic commodity in the north target showed visual discoloration, soot deposition and damage, no sustained combustion of the commodity was observed

- **None** of the plastic trays stored adjacent to the initiating storage location both inside and outside of the horizontal and vertical barriers sustained visual damage.

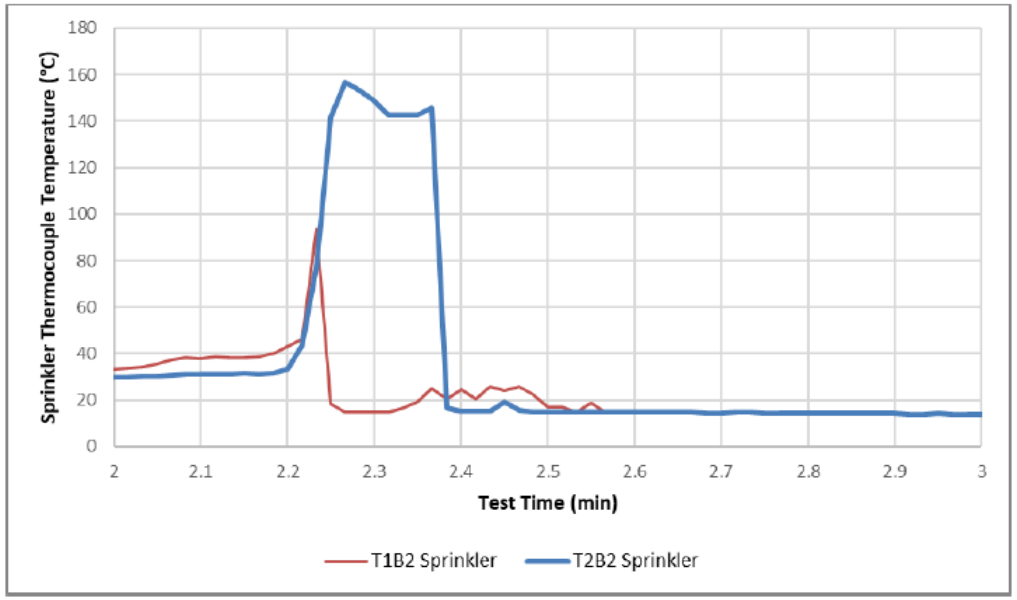



Figure 27: Sprinkler operation indicated by thermocouple measurements

Figure 32: Charring, soot deposition, and water damage on northern target array

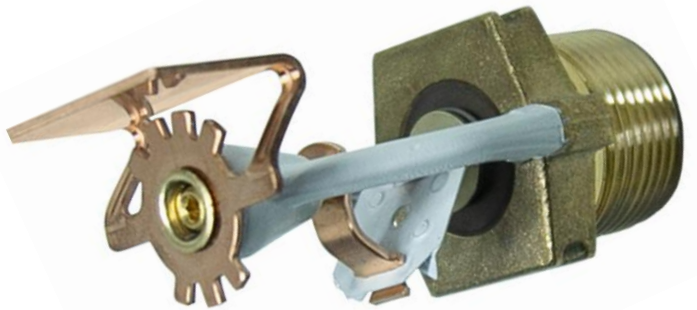
## Key Points:

- Full suppression, then extinguishment achieved
- The fire did not jump across the aisles to the other racks
- None of the plastic trays were damaged

Thanks For Your Attention

# Questions?

N28



LB11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