Optimizing sprinkler design for the AutoStore System



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FG Sprinkler Konferansen 2026

AutoStore

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Main message

Effective Sprinkler Protection is achieved through a combination of system understanding, fire testing and data-driven decision making.



Understand the challenge



Generate evidence

Table 2.3.2.3.3.1. Ceiling-Level Sprinkler Protection Guidelines that Reduce Some of the Final Extinguishment Recommendations when Protecting Solid-Walled Containers Stored to a Maximum Height of 20 ft (6.1 m) in a Top-Loading ASRS Storage Arrangement; Maximum Ceiling Height of 30 ft (9.1 m)

Max. Ceiling Height, ft (m)	*Maximum Vertical Distance of Sprinkler Thermal Element Below Ceiling, in. (mm)*	*Ceiling-Level Sprinkler Protection Options for Solid-Walled Containers to Maximum 20 ft (6.1 m) in a Top-Loading ASRS Storage Arrangement; No. of AS @ psi (bar)*					
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*This ceiling height is recommended only for locations where the grid that supports the robots is at least 8 ft (2.4 m) below the underside of the ceiling.

Apply insights to optimize fire protection

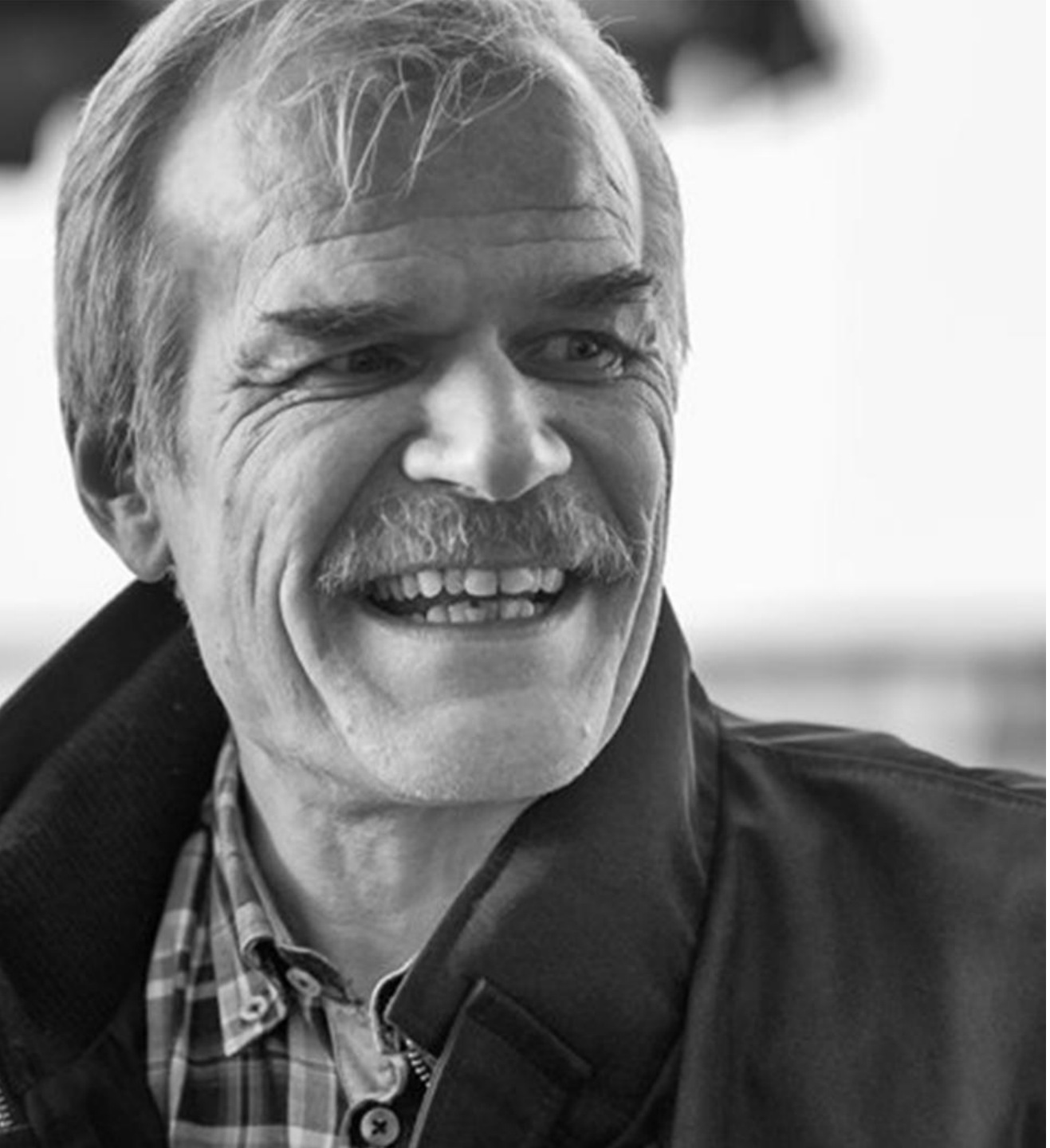
AutoStore.

Moving Things Forward



AutoStore | Where did it all start?





How it started

In the 90’s, we were a very successful electronics component distributor.
As the largest distributor in Northern Europe, we build ourself a new big warehouse to secure our future growth. But after few months it was already full of inventory, and instead of building another expensive warehouse – we were forced to think differently.

Our Technical Director Ingvar Hognaland came up with the genius idea of removing the most wasteful and expensive component of our warehouse – the areas only filled with air.

That inventive idea resulted in the game-changing Cube Storage Automation system - **AutoStore™**

For over 20 years we have continued to innovate and improve our system to help our customers all over the world

About AutoStore



1996

AutoStore, founded in 1996,
is a global technology company that
develops robotics and advanced
software to automate
and orchestrate order fulfillment.

2,000 +

AutoStore has more than
~ 1,850 systems with ~ 82,500 Robots in
over 65 countries.

1,000

AutoStore has more than
1,000 employees, and
nearly 300 work in the
product business unit.

23

AutoStore has 23 distribution and
installation partners and an in-house
sales teams, equal to ~ 3,000 certified
sales representatives world-wide.

The AutoStore System

Bins

Products are stored in Bins – durable containers that hold up to 30 kg. On average sites stack around 40,000 Bins, with the largest holding nearly 2 million.

Robots

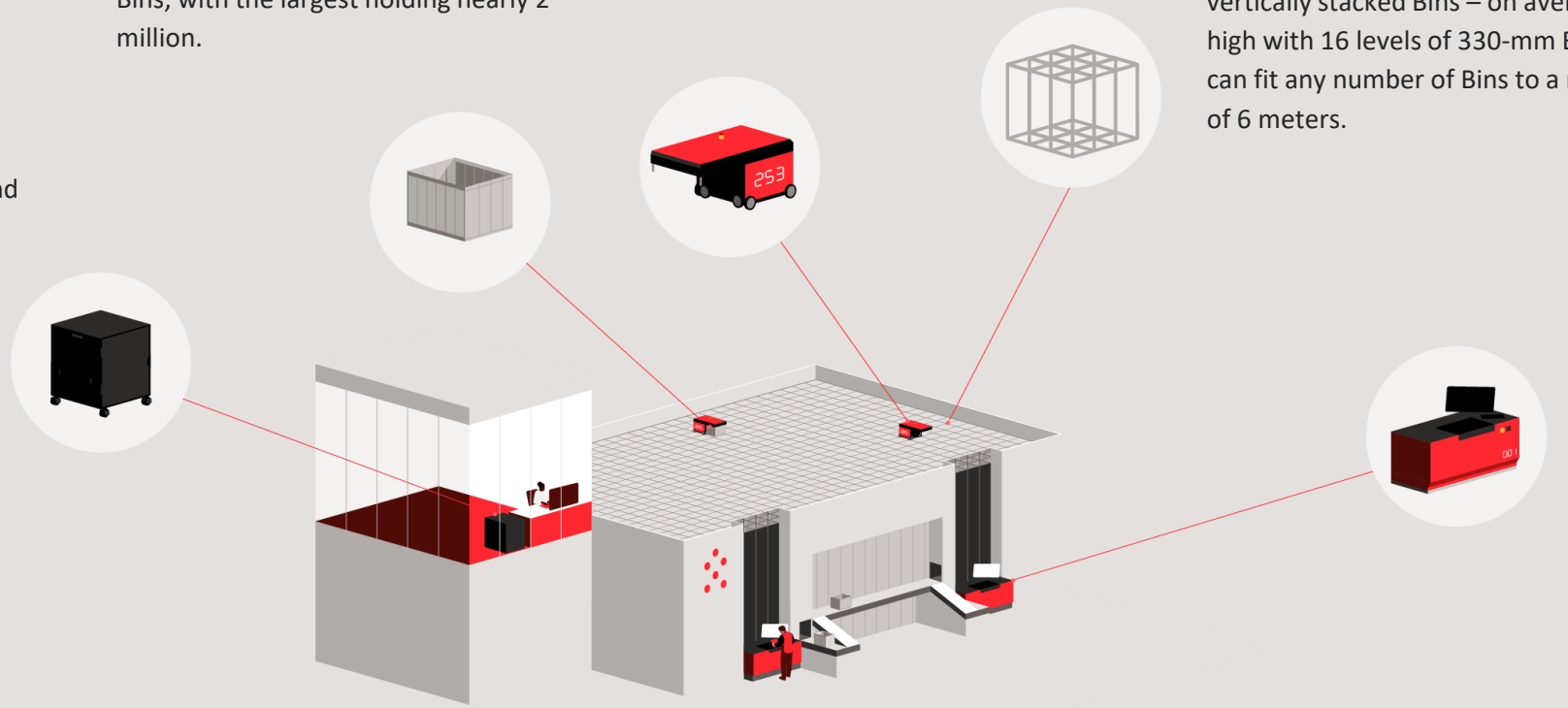
Robots ride on rails along the top of the Grid, retrieving Bins as needed. On average sites run around 45 Robots, with the largest exceeding 2,000.

Grid

The Grid is an aluminum framework for vertically stacked Bins – on average 5.5 meters high with 16 levels of 330-mm Bins, but a Grid can fit any number of Bins to a maximum height of 6 meters.

Controller

The Controller is the command center and uses the cube control software to manage both Bin traffic and the AutoStore database.



Ports

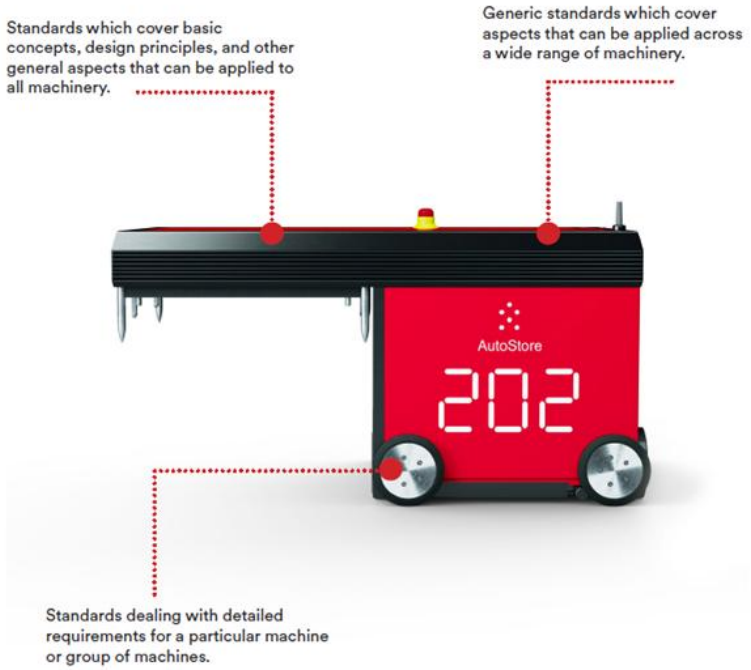
Ports are workstations where operators pick, replenish, tag, pack, and distribute items. On average sites have around 10 Ports, with the largest equipped with over 300.

Product Safety

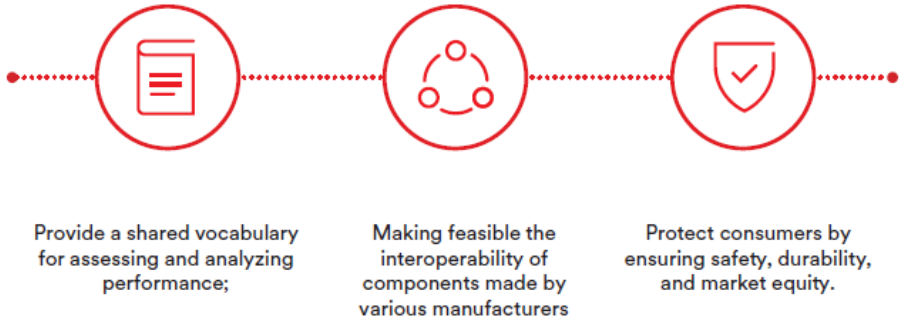
Product Safety – Leading edge technology

AutoStore™ is a black box system, but it needs to be approved.
Can the standardization work keep up the pace with new technology?

At the most basic level, standards are an agreed way of doing something. They establish uniform engineering or technical criteria, methods, processes, and practices. Standards fall into a few main categories:

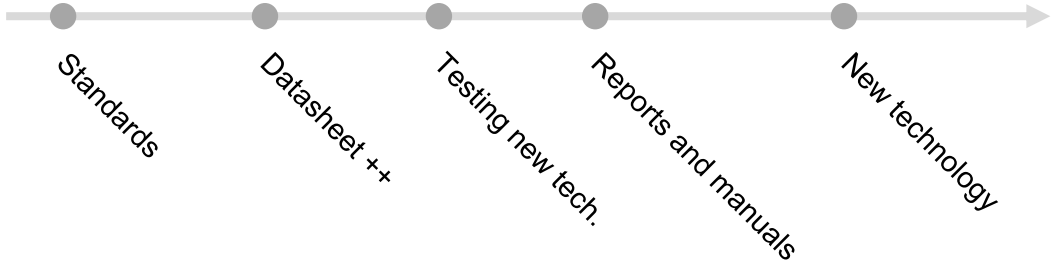


Standards allow technologies to work seamlessly as well as establish confidence so that markets can operate smoothly.



Can the standardization work keep up the pace?

How can consultants be up to date on the work going on?



Product Safety



AutoStore has a relentless focus Product Safety, among other:

- Electrical Safety
- Fire Safety
- Seismic
- Machine Safety

All AutoStore's Electrical Components meet the minimum requirements for product safety as outlined by different regulations worldwide. The testing are conducted at National Recognized Testing Laboratory (NRTL) or Notifying Body (NB)

AutoStore submits requst to NRTL / NB → NRTL / NB Independently tests product → Factory Inspection (only applicable in the US) → NRTL / NB issues technical report → Authorization to Mark

The AutoStore System

Product Safety

Robots

Robots are certified to CE, IEC/ETL.

Constructed of metal and fire-retardant material

Bins

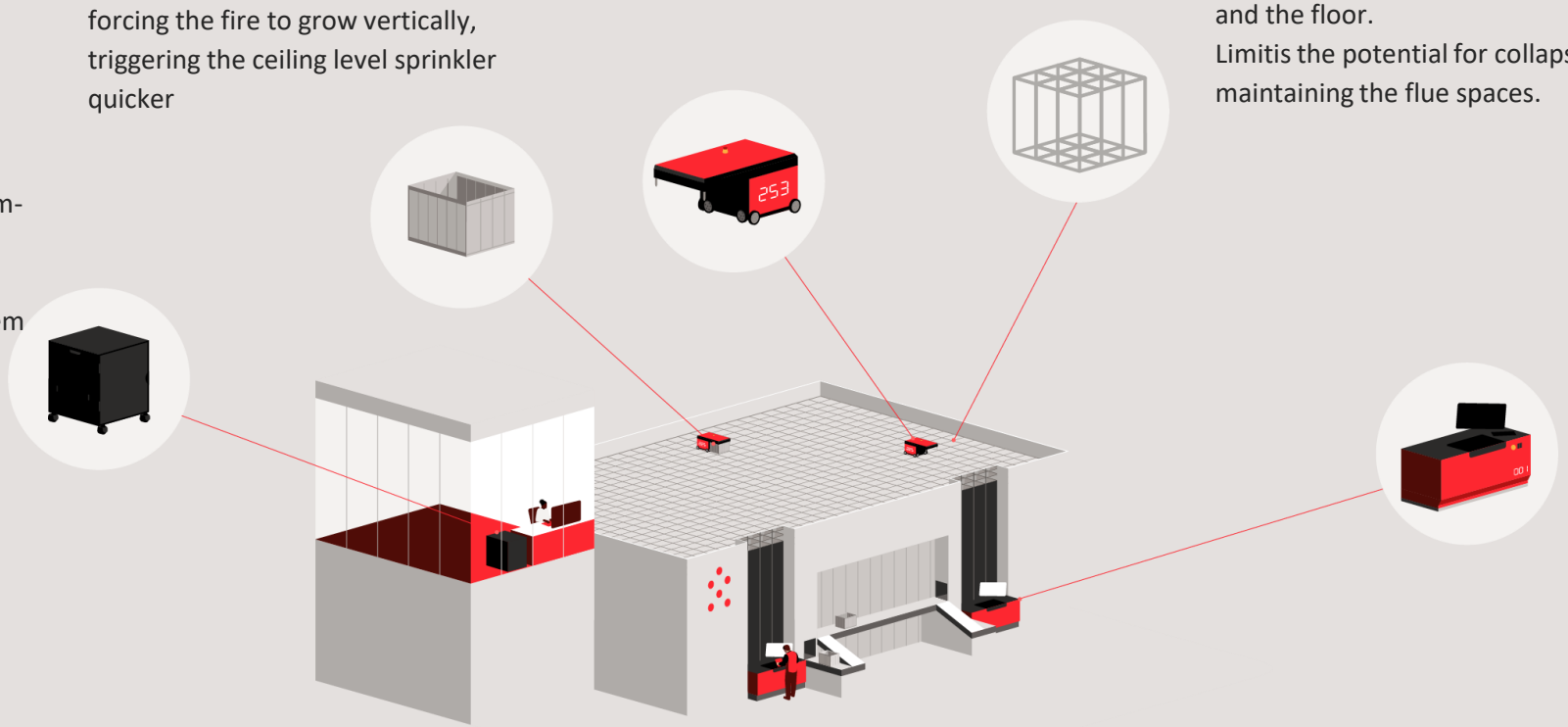
Solid-walled bins, limiting the air movement inside of the system, forcing the fire to grow vertically, triggering the ceiling level sprinkler quicker

Grid

Designed to allow water flow to the lower levels and the floor.
Limitis the potential for collapsing bins, maintaining the flue spaces.

Controller

Can be connected to the alarm-system within a facility and upon alarm stop the robots – either in location or move them to safe zone



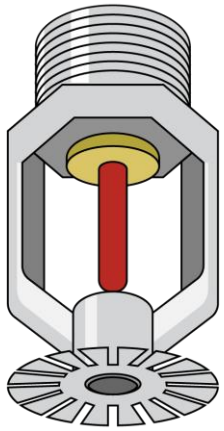
Ports

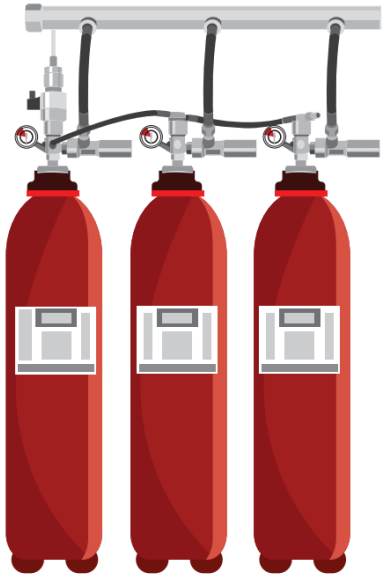
Certified to CE, IEC, ETL

Industry leader within Fire Safety and Testing



Industry Leader within Fire Safety and Testing







Since 2009, AutoStore has conducted over 120 small-, intermediate- and large-scale fire tests.

Different fire protection options have been tested:

- Foam
- Ceiling level Sprinklers
- Oxygen Reduction
- Inert gas (Preliminary tests)

Test Laboratories:

RISE Research Institute Sweden

Underwriters Laboratories, Chicago

AutoStore | Fire Test Summary

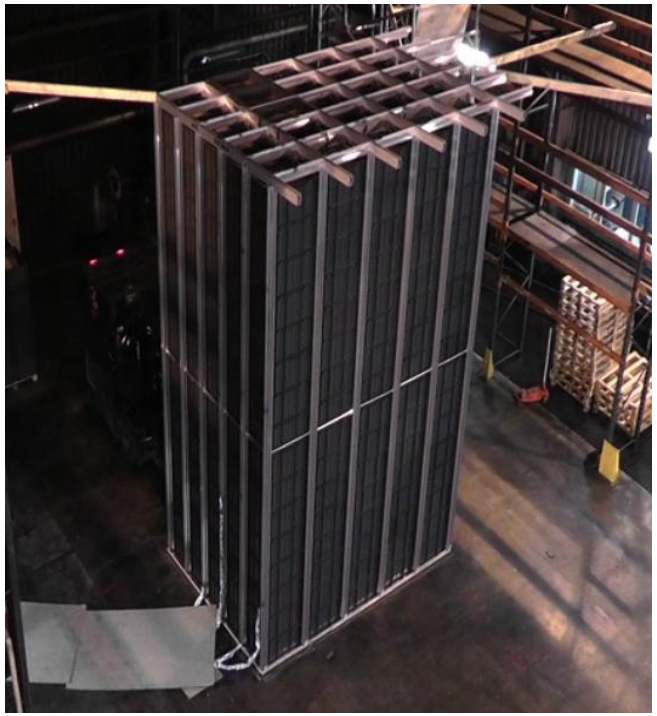
DATE	REPORT	DESCRIPTION
Aug. 2009	RISE Research Institute Report: RISE: P903499/Rev.1	Small-scale test - comparing fire characteristics of the primary two plastic compounds, HDPE and PP-ESD, used in AutoStore Bins
Dec. 2009	RISE Research Institute Report: RISE: P903510	Large-scale test - first series of large-scale tests using a high-expansion foam system
Sept. 2009	RISE Research Institute Report: RISE: P904143	Large-scale test - second series of large-scale tests using a high-expansion foam system
Mar. 2010	RISE Research Institute Report: RISE: PX00778	Small-scale test - 2 alternative HDPE and PP-ESD plastic compounds tested & compared to earlier tests in project P903499
Apr. 2010	RISE Research Institute Report: RISE: P907897	Large-scale tests - free-burn fire tests of fire growth rate during initial phase of a fire in a representative section of a system
Mar. 2011	RISE Research Institute Report: RISE: PX10701	Ignitability tests according to UL 94, “Standard for Safety of Flammability of Plastic Materials for Parts in Devices & Appliances
Apr. 2011	RISE Research Institute Report: RISE: PX11228	Ignitability tests according to UL 94, “Standard for Safety of Flammability of Plastic Materials for Parts in Devices & Appliances
Jun. 2011	RISE Research Institute Report: RISE: PX12667	Ignitability tests according to UL 94, “Standard for Safety of Flammability of Plastic Materials for Parts in Devices & Appliances
2012 - 2013	RISE Research Institute Report: RISE: PX03821-02-01--5	Series of 5 ignitability tests according to IEC 60695-11-5 (2004) and UL 94 (2015)
Jun. 2012	Underwriters Laboratories, Inc. Report: UL: 12CA13688, NC 13069	Four large-scale tests of control-mode sprinkler tests were conducted at Underwriters Laboratories, Inc
Oct. 2012	Underwriters Laboratories, Inc. Report: UL: 12CA40286, NC13069	Large-scale test of water distribution tests with upright sprinklers
Feb. 2013	RISE Research Institute Report: RISE: PX27939-1	Series of 3 tests of fire barriers for within the Grid, per VdS CEA 4001en
Feb. 2013	RISE Research Institute Report: RISE: PX27939-2	Free-burn fire tests of fire growth rate during the initial phase of a fire in a palletized storage arrangement of the HDPE Bins
Jul. 2014	RISE Research Institute Report: RISE: 4P04364	Small-scale tests of plastic compounds to compare a PP-C and HDPE compounds used for the Bins
Oct. 2014	RISE Research Institute Report: RISE: 4P05641	Small-scale tests of plastic compound of PP EL plastic compared to the two different plastic compounds tested and reported in 4P04364
Feb. 2016	RISE Research Institute Report: RISE: 5P09926	Small-scale comparison tests to compare the fire characteristics of PP-C with different fire-retardant additive combinations with HDPE
Oct. 2016	RISE Research Institute Report: RISE: 5P05412	Intermediate-scale fire tests comparing AutoStore Bin designs
Oct. 2016	RISE Research Institute Report: RISE: 6P02895	Two pre-tests of Early Suppression Fast Response (ESFR) sprinkler conducted using the combination of parameters that had proven to be the most severe in the intermediate-scale fire tests
Mar. 2017	Underwriters Laboratories, Inc. Report: UL: 4787818459, NC13069	Four large-scale tests of Early Suppression Fast Response (ESFR) sprinkler verification tests
Feb. 2018	RISE Research Institute Report: RISE: 7P07649	Medium-scale tests of Influence on fire suppression performance using Bins with lids
May 2019	RISE Research Institute Report: RISE: 8P08096	Test to measure the amount of water collected from a representative Early Suppression Fast Response (ESFR) sprinkler that is collected in the top layer of Bins of an AutoStore Grid
2018	Wagner Group GmbH	Large-scale fire test of an AutoStore system under reduced oxygen concentration
Sept. 2019	RISE Research Institute Report: RISE: 9P03067A	Comparison of HDPE and PP-C Bins with and without drainage holes and final extinguishment tests with medium-expansion foam
Sept. 2019	RISE Research Institute Report: RISE: 9P03067B	Summary report on the influence of water drainage holes in AutoStore system Bins
Mar. 2020	RISE Research Institute Report: RISE: 9P08958	Series of intermediate-scale fire tests were conducted to provide an indication of the fire suppressibility and severity of a fire in H220, H330 and H425 Bins
Feb. 2021	RISE Research Institute Report: RISE: P106771	Intermediate-scale top bin ignition tests with H220, H330 and H425 bins
Feb. 2021	Western Norway University of Applied Sciences (HVL) Report: INERGEN	INERGEN distribution test and fire tests with ignition floor level and top bin
May 2021	Underwriters Laboratories, Inc. Report: UL: 4789911434, NC13069	Large Scale Sprinkler tests with the AutoStore system incorporating polypropylene plastic bins with cartoned unexpanded group A plastic commodity including Fire Fighter Response test
Feb 2022	RISE Research Institute Report: RISE: P113643	Small- and intermediate-scale fire test using AutoStore bins filled with glass bottles with fragrant liquid
Mar. 2022	Underwriters Laboratories, Inc. Report: UL: 4790300461, NC13069	Large Scale Sprinkler Tests With the AutoStore System Incorporating Polypropylene Plastic Bins With Cartoned Unexpanded Group A Commodity for 30 ft. Tall Ceilings
Jun. 2025	Underwriters Laboratories, Inc. Report: UL: 4791779075, NC13069	Large Scale Sprinkler Tests with the AutoSTore System Incorporating Polypropylene Plastic Bins With Cartoned nonexpanded Group A Plastic Commodituy for 28 and 30 ft. Tall Ceilings

Comparison AutoStore and Pallet

Comparison Pallet vs AutoStore (2013)

How you store your inventory has an impact on the fire development.

AutoStore



Same Bin

Different Storage method

Ignition Floor level

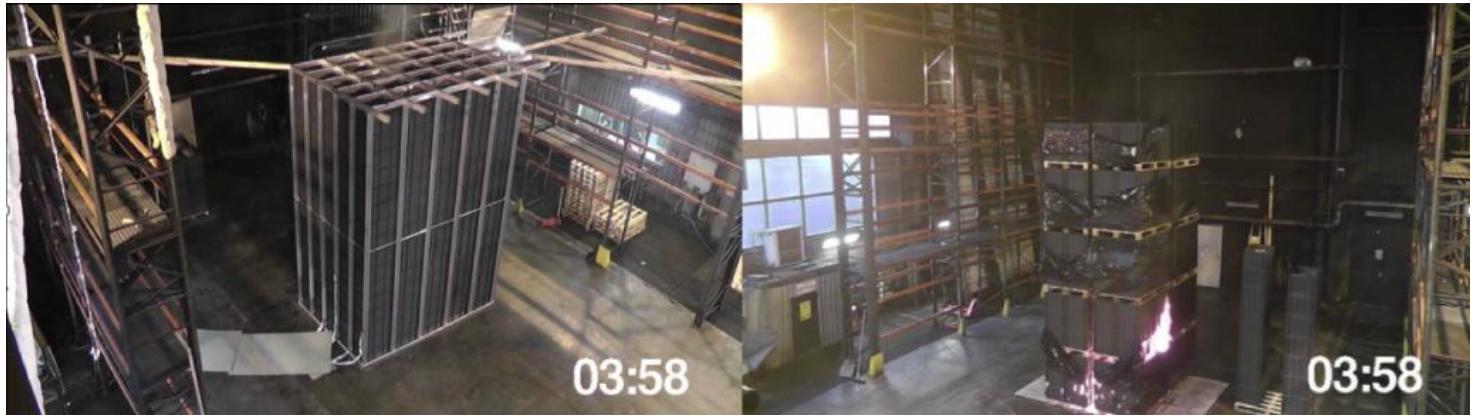
Standard Test Commodity

Pallet Storage

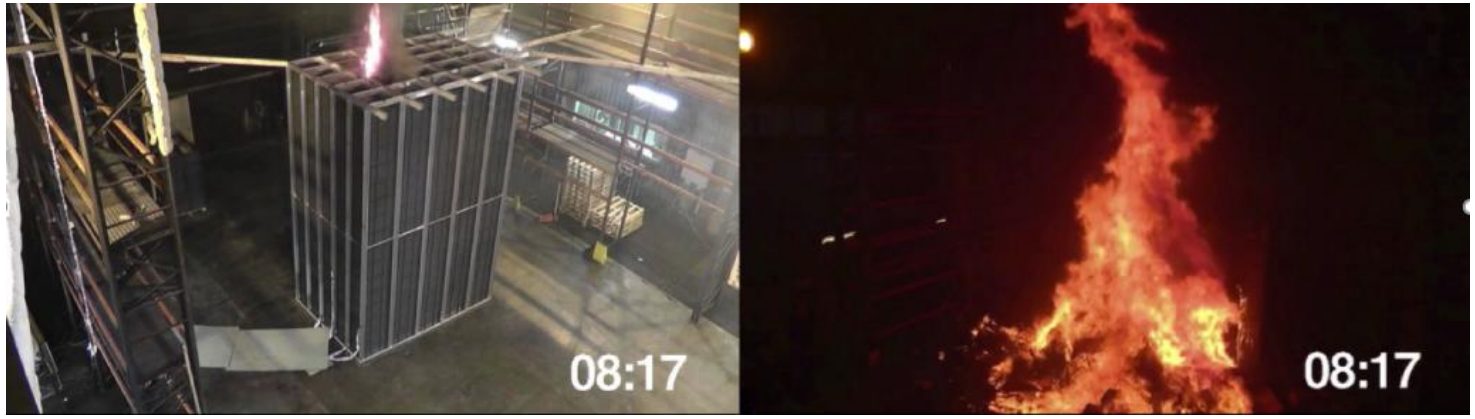


Findings

4 min: Visible flames on the outside of the pallets, on the side. Only smoke from the AutoStore unit

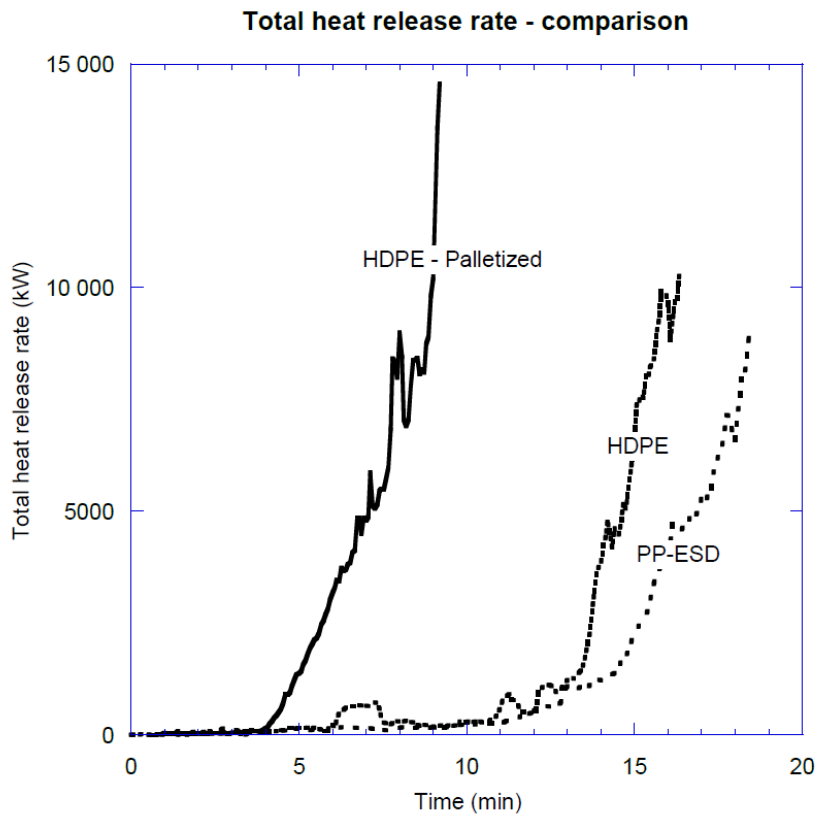


8 min: Visible flames above the AutoStore unit, the pallets storage has collapsed



Conclusion

Heat Release Rate



Conclusion

How the storage array is constructed has an impact on the fire development

The initial fire growth rate is significantly faster for the bins in pallet storage compared to the AutoStore system

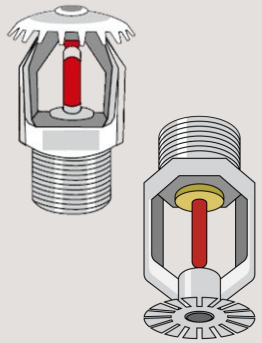
AutoStore – Optimizing sprinkler design

Findings through our tests

Adequate fire protection

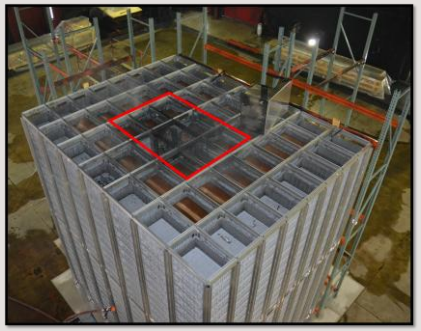
Several protection options valid for an AutoStore system:

Automatic Sprinklers
Oxygen Reduction
Foam



Rapid Vertical Spread - Limited Horizontal damage





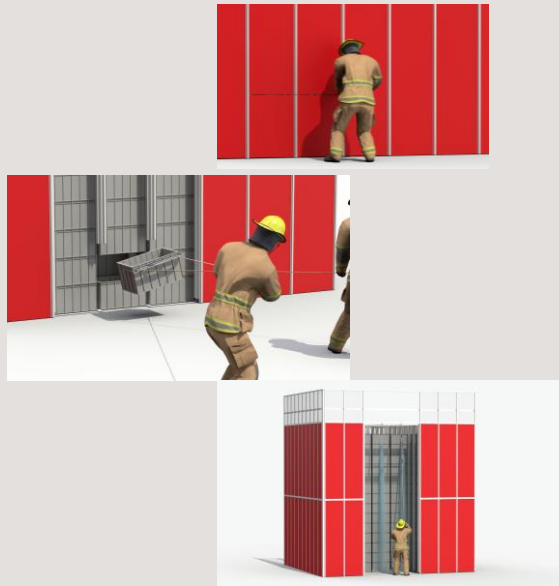
Final extinguishment

Can be achived with ceiling level sprinklers only – following design in the FM DS 8-34 (Table 44) – to be updated in April 2026 version.

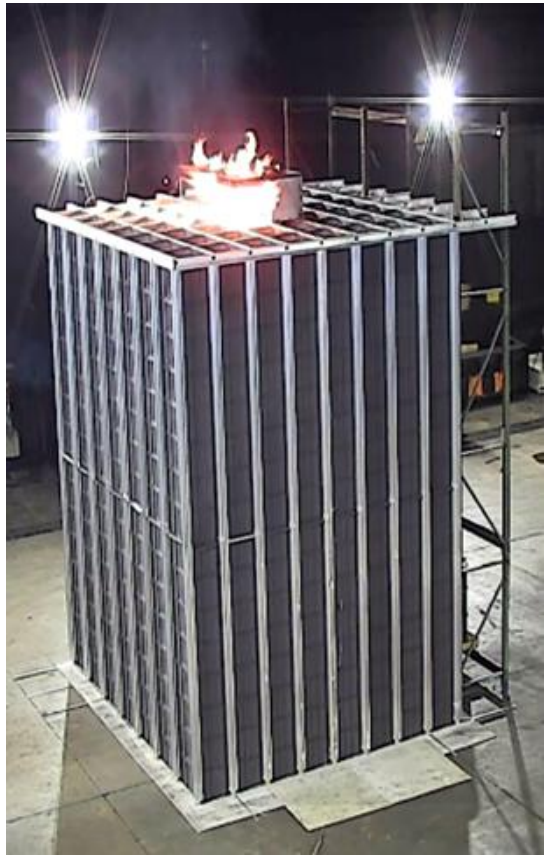


Manual intervention

Method developed and verified for manual intervention by the fire services



Status before June 25



March 2022:

Final extinguishment achieved for a ceiling height of 9.1 m. Pressure of 8.3 bar with positive results.

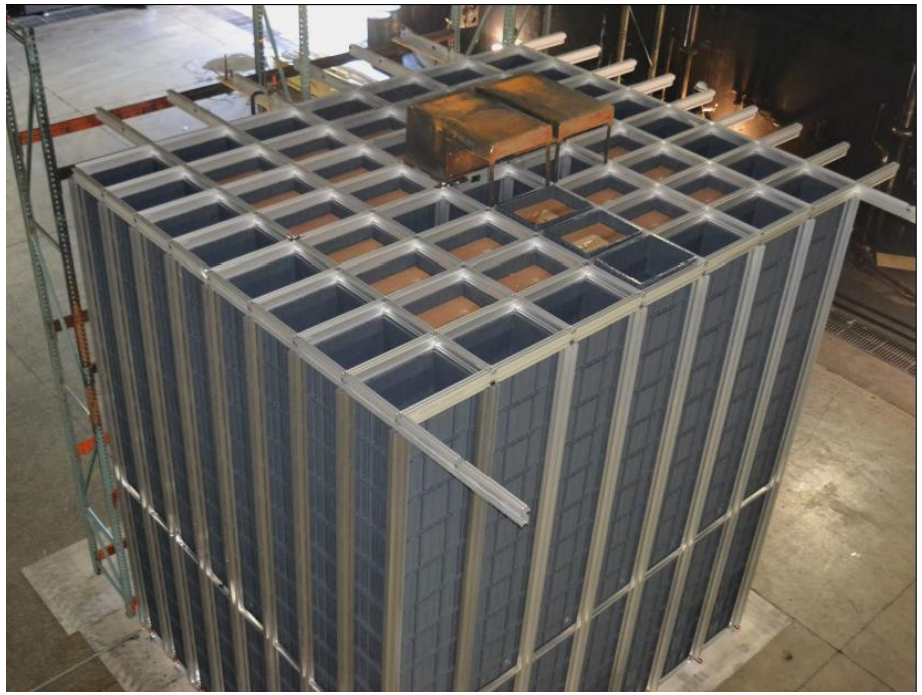
Results:

- Limited fire spread
- Limited number of sprinklers operating (maximum 3)
- All within time limit of 2 hours water supply duration
- Between 4 sprinklers worst-case scenario
- Design implemented into the FM DS 8-34 January 23

Table 44. Alternative Ceiling-Level Sprinkler Protection Options for Top-Loading ASRS Arrangements that Address Final Extinguishment; Maximum Storage Height up to and Including 20 ft (6.1 m)

Max. Ceiling Height, ft (m)	*Maximum Vertical Distance of Sprinkler Thermal Element Below Ceiling, in. (mm)*	*Alternative Ceiling-Level Sprinkler Protection Options for Top-Loading ASRS Arrangements that Address Final Extinguishment; No. of AS @ psi (bar)*					
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30 (9.1)	13 (325)				6 @ 120 (8.3)	6 @ 95 (6.6)	6 @ 65 (4.5)

Test Set-up



Set-up	
Storage height [m]	5.3
Ceiling height [m]	8.5
Nominal Clearance [m]	2.4
Deflector Distance [mm]	356
Ignition location	Between 4 sprinklers
K-factor	360
Sprinkler Pressure [bar]	4.5

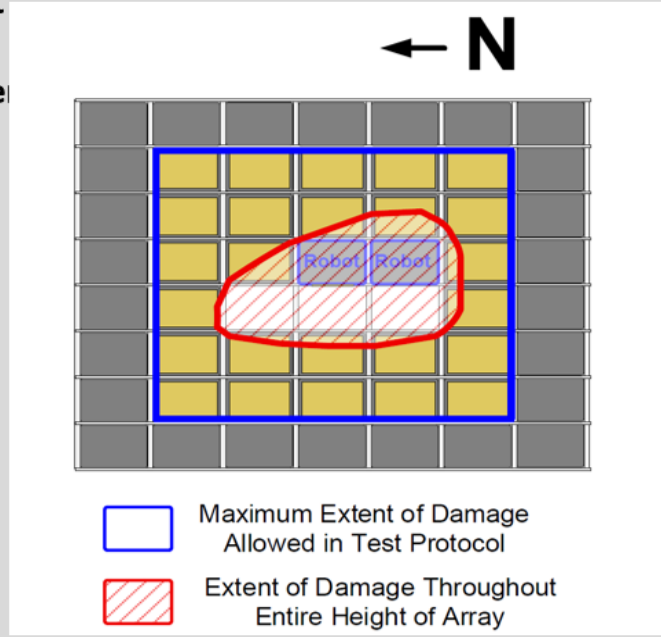
Optimizing Sprinkler design

Test 3 – 8.5 m ceiling height

A 0.6 m reduction of the ceiling height from 9.1 m to 8.5 m significantly decreased the pressure of the sprinkler system.

Final Extinguishment achieved with:

- 4.5 bar pressure
- 2 operating sprinklers
- 2 hour water supply duration
- Limited fire damage



New Design for 8.5 m included in the FM DS 8-34 April 2026 revision.

Key take-aways



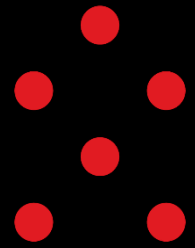
Table 2.3.2.3.3.1. Ceiling-Level Sprinkler Protection Guidelines that Reduce Some of the Final Extinguishment Recommendations when Protecting Solid-Walled Containers Stored to a Maximum Height of 20 ft (6.1 m) in a Top-Loading ASRS Storage Arrangement; Maximum Ceiling Height of 30 ft (9.1 m)

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*This ceiling height is recommended only for locations where the grid that supports the robots is at least 8 ft (2.4 m) below the underside of the ceiling.

AutoStore do not guess – AutoStore tests

- Several options for adequate fire protection available
- Final extinguishment can be achieved with ceiling level sprinkler only with three different ceiling heights
- Reducing ceiling height by **0.6 m** – lead to a **46 % decrease** in sprinkler design pressure
- A limited number of sprinklers operate during the tests, and
- No skipping effect has been observed in our tests
- **New design in FM DS 8-34 April 2026 revision (Table 2.3.2.3.3.1)**



Thank you for your attention!

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