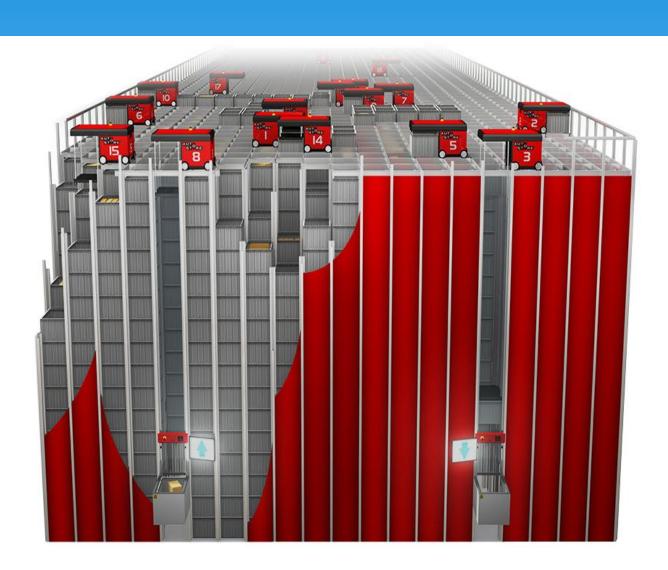
Auto Store

Automatic warehouse pick system



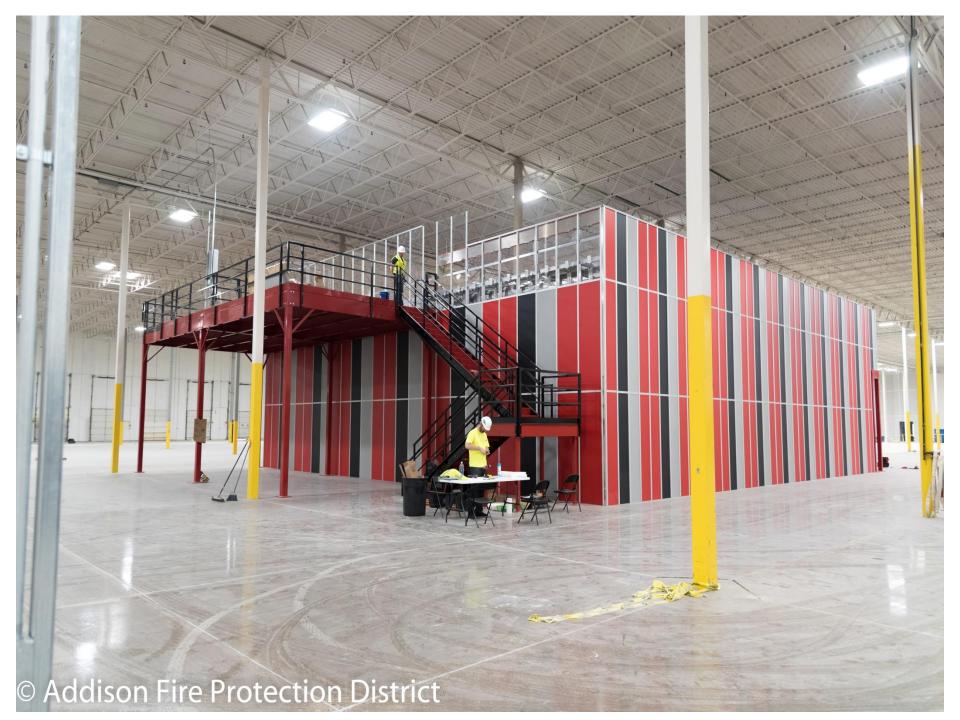
Auto Store System

- * AutoStore is an automated warehouse system that stores goods in plastics boxes.
- * These boxes are stacked inside an aluminum grid structure and are picked up and delivered to picking
- * stations by robots.
- * The system is usually 16 boxes in height (i.e. 5.4 m) while the number of total boxes is in theory unlimited.
- * The average installation consists of 30,000 to 40,000 boxes, with the largest installation so far having 180,000 boxes.

Auto Store System Design

- * An aluminum Grid provides the storage space for all your goods.
- * The size and form of the Grid is only limited by the warehouse around it. Ensures optimal space usage.
- * Product stored in plastic bins inside the grid
- * Robots are the real workforce of the AutoStore system.







How It Works

- * Robots move tirelessly on rails on top of the Grid hoisting up Bins, moving them for further processing and then placing them back into the Grid.
- * When goods from the bottom of the Grid are requested the Robots will work together to dig their way to the target Bin.
- * The Robots continuously optimize the storage position of goods inside the Grid, placing often requested Bins on the higher levels.
- Ports are the interface between the storage area and your warehouse staff. It's here that the Bins leave the Grid for further processing.



Robots

- * Robots are AutoStore's iconic laborers. They are powered by rechargeable batteries and operate autonomously on top of the Grid.
- * Each Robot features a lift that allows it to pick and place Bins in the Grid.
- * The Robots receive their orders wirelessly from the control system, sending them to and from the Ports and ordering them to recharge whenever needed.
- * Robots are both strong and agile: They handle 5 kg Bin weight and up to 30 kg of goods.

The Bins

- All goods are stored in standardized, specially designed plastic containers called Bins.
- * Every single Bin is identified by a unique number that is stored in the controller database and repeated on a label on the Bin itself.
- * The Bins can be divided into different compartments to accommodate different product categories.
- * The Bins never have to be removed from the Grid and are returned to storage at once an item has been processed.



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AutoStore Design Advantages

- * Storage is compact with narrow flue spaces (air movement restricted).
- * Flue spaces always regular.
- *Storage array is stable (collapse not likely during initial fire development).
- * Vertical aluminum supports limits possibility of horizontal fire spread.

AutoStore Design Disadvantages

- * Bins have solid bottoms.
- * Bins have no lids (initially, water will collect in top bins.
- * Narrow flue spaces will limit the amount of water reaching the seat of the fire.
- * Grid track over the flue spaces will limit water going directly down the flue spaces.

AutoStore History

- * AutoStore manufacturer initially had no experience concerning fire safety. They felt that it was impossible for a fire to start inside the system.
- * In 2007 AutoStores first customer (in Germany) required a VdS approval for the System.
- * VdS is Germany's leading independent testing institution.
- Initial meetings between manufacturer and VdS concluded that the best solution was extinguishing system using light foam.

- * AutoStore and VdS worked with Norconsult of Norway and ran small scale fire tests to ensure that foam worked.
- * Small scale testing was not enough to gain the VdS approval.
- * Large Scale testing was needed. The manufacturer contacted the Technical Research Institute of Sweden (SP) and created list of priority questions that needed to be answered.

* The priority questions were:

- * Which method was most effective for extinguishing the plastic boxes used.
- * How fast could a fire spread inside AutoStore.
- * What was the best system to detect a fire.
- * Which method would work best in a compact system like AutoStore.
- * These questions needed answering before they could gain VdS approval.....

* AutoStore manufacturer had two main goals:

- * Wanted to satisfy VdS' demands and receive an official approval of the system that would be acceptable to the customer.
- * Did not want to change the overall design of the system.

Large Scale Testing

- * VdS and SP's Large Scale Testing Project began in 2009.
- * Testing is still on-going because AutoStore System in continuously being further developed.
- * Initial test plan was to run tests with light foam.
- * During the test they also looked at other variables:
 - * Fire Detection
 - Foam Distribution Inside the System

- * AutoStore gained VdS approval in 2010 for a solution based on light foam (specific to their customer).
- * AutoStore moved on to a large scale sprinkler test. Knowledge gained from first testing boiled down to three main points:
 - * Fire Expansion is Slow
 - * Water could be used as extinguishing agent
 - No pool fires were found at the bottom of the System

- * AutoStore wanted to find out if it was possible to stop a fire with conventional sprinklers.
- AutoStore approached SP. Initial testing was done in 2010 with promising results.
- * AutoStore approached VdS to request approval for their entire system, not just for the specific customer installation.
- * Decided that full scale tests were necessary.
- * Full Scale Tests were too big to be done at SP.
- * Testing Done at U.L.

U.L Test Data

* Full Scale Tests:

- Four tests conducted at UL. (Northbrook)
- Objective was to establish an efficient sprinkler protection concept.
- Tests reported to be successful.
- Damage criteria exceeded in one test.

Test Criteria

- Maximum 10 operating sprinklers.
- * Steel beam at ceiling above fire ignition should not exceed 540°C (1004°F) for more than one minute (same as UL199).
- Ignition on the inner faces of the stacks of bins surrounding the center 5 by 6 cells was not allowed.

Test Grid and Ignition Source

- 7 by 10 cells.
- 16 bins per cell.
- Overall height was approximately 17 feet.
- Bins made from HDPE.
- Each bin had 3 small Group A Standard Plastic commodity cartons with 12 polystyrene cups.
- Ignition source was a cube of low density fiber board, soaked with heptane and wrapped in a polyethylene plastic foil bag.

Tests and Results

- Four tests:
- Test 1– Completely filled cells, ignition between 4 sprinklers, 17.7 feet ceiling clearance, 0.6 gpm/sq. ft. density.
- Test 2– Completely filled cells ignition under 1 sprinkler, 17.7 feet ceiling clearance, 0.6gpm/sq. ft. density.
- * Test 3– 2 cells partly empty, ignition under 1 sprinkler, 9.85 feet ceiling clearance, 0.7 gpm/sq. ft. density.
- * Test 4– Completely filled cells, ignition under 1 sprinkler, 9.85 feet ceiling clearance, 0.7 gpm/sq. ft. density.

- Tests 2 and 4 had only 1 sprinkler activate.
- Test 1 had 3 sprinklers activate.
- Test 3 had 4 sprinklers activate.
- Activation times were between 15 and 16 minutes for tests 1 and 2 (higher ceiling); and 7 and 9 minutes for tests 3 and 4 (lower ceiling).

Summary

- Tests represent a starting point for sprinkler protection requirements.
- NFPA 13 does not directly address this configuration
 - * If you apply Chapter 15 criteria, your density would be 1.1 gpm/sq. ft. The tests used between 0.6 and 0.7 gpm/sq. ft.
- * If an owner requests fire protection for this type of system.....

Firefighting Operations and Concerns

- * Access to the storage array is limited at best.
- * Hose lines and water distribution will have to be from the top and as with the sprinklers, water to the fire will be limited.
- * Tactically, based on the construction and make up of the system the best form of extinguishment (if needed) might be high expansion foam.

Fire Prevention Concerns

- Mandatory evaluation of any sprinkler system prior to installation of an AutoStore system.
- * Based on the full scale test results and time of sprinkler activation does a fire detection system need to be installed above the AutoStore systems (smoke/heat detection)?
- * Column protection within the grid system?
 - * 1 hour fire safing
 - * 2 hour fire safing
- * Insurance carrier requirements?

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- Brandposten Report on the Testing and Results
- Other information found in the AutoStore VdS Concept report of June 2015
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