Protection Strategies for High Hazard Plastics Storage

Contents

Steven Wolin

Tom Pedersen

Steven Wolin
• Global home furnishing retailer, founded by Ingvar Kamprad

• Began operations in the region of Småland, Sweden, in the 1950’s

Ingvar Kamprad Aggunaryd

Småland, Sweden
<table>
<thead>
<tr>
<th>IKEA Group</th>
<th>Inter IKEA Group</th>
<th>Other Owners</th>
</tr>
</thead>
<tbody>
<tr>
<td>309 Stores 26 countries</td>
<td>Inter IKEA Systems B.V. (Franchisor)</td>
<td>45 stores</td>
</tr>
<tr>
<td>IKEA Retailers AU AT BE CA CN CZ DK FI FR DE HU IT JP NL NO PL PT RO RU SK ES SE CH UK US</td>
<td></td>
<td>IKEA Retailers AU CN CY GR IS IL KW SA ES TW TR AE MY SG</td>
</tr>
</tbody>
</table>

1 Store

Total number: 355 IKEA Stores in 44 countries

Shopping Centres
Distribution Centres
Factories
Retail, distribution, production: operations in 43 countries

**NORTH AMERICA**
- 50 Stores
- 3% Purchasing value
- 6 Distribution centres
- 1 Trading service office
- 1 IKEA Industry production unit

**EUROPE**
- 215 Stores
- 60% Purchasing value
- 19 Distribution centres
- 11 Trading service offices
- 36 IKEA Industry production units

**RUSSIA**
- 14 Stores
- 3% Purchasing value
- 1 Distribution centre
- 3 Trading service offices
- 5 IKEA Industry production units

**ASIA**
- 19 Stores
- 33% Purchasing value
- 5 Distribution centres
- 12 Trading service offices
- 2 IKEA Industry production units

**SOUTH AMERICA**
- 1% Purchasing value
- 1 Trading service offices

**AUSTRALIA**
- 5 Stores
- 1 Distribution centre

- 303 IKEA Group stores
  Located in 26 countries

- 684 Million visitors
  to the IKEA Group stores

- 60% of production
  takes place in Europe

- 1,046 home furnishing
  Suppliers
  In 52 countries

FY13 Figures
Changes in Product range

• 1958 – 1970’s
  • Most wooden products
  • More or less everything in cardboard boxes
Changes in Product range

• 1980 –
  • More and more plastic products in our range
  • New products / range
  • Not packaged in cardboard boxes
  • Shrink wrapping
Study of one US Store in 2009 and one US Distribution Center in 2014 per NFPA Classifications.
New challenges

- More plastics in Product range
- New storage solutions
  - Silos (dense & automated)
  - High Level picking
- Increased Storage & Ceiling height
- New markets
**History**


IKEA Fire Prevention

- Non combustible building materials
- Routines / Fire Response Team
- Fire protection systems
  - Fully addressable detection
  - Sprinkler
  - Smoke extraction
• Need for internationally accepted protection criteria
• Development and testing since the 1990’s in cooperation with: SB, VdS, NFPA, FM, and others
• Criteria with FM in 2001 (NFPA)
• Criteria with VdS in 2007 (EN)
Fire Codes

• As the product range and storage configurations are continuously changing, code requirements need to adapt to the changing needs!

• Rapid update cycles are important to the end users
Fire Codes

- EN 12845
- CEA 4001
- NFPA 13
• Development started in 1990.
• First edition published in 2004
• Proposals for next version prepared in 2005-09.
• Due to lengthy process, earliest issue of next version in 2015
• Not an official code, and only supported by some countries in Europe.
• Latest version from 2013, but no regular update process.
• Committee meetings are not open for the public, and the technical basis for many decisions cannot be evaluated.
• Updated version every 3rd year
• Internationally recognised
• Open process
  – Allows public proposals and input
• Supported by Fire Protection Research Foundation
• New criteria needed: rack storage of exposed expanded plastics!
Figure 17.1.2.1

- Group A
  - Cartoned, expanded or unexpanded, and exposed, unexpanded
    - Stable (see Chapter 17)
    - Free-flowing Class IV
  - Exposed, expanded (outside the scope of Chapter 17)
- Group B Class IV
- Group C Class III
- Plastics
#1 priority in storage and #2 priority overall:

– Protection of Expanded Group A Plastics in Rack Storage
Sponsors

- IKEA
- Viking Sprinkler
- Reliable Sprinkler
- Tyco Fire and Building Products
- XL Insurance
- Property Insurance Research Group
- Procter & Gamble
- Target
- Aon Insurance

Technical Panel

- Ken Linder, Swiss Re
- Jason Huczek, Southwest Research Institute
- John Denhardt, Strickland Fire Protection
- Steve Wolin, Code Consultants, Inc.
- Matt Klaus, NFPA Staff Liaison

Project Contractor

- Underwriters Laboratories
www.nfpa.org/foundation
Reports
Suppression
Applications
The Current Fire Challenge for IKEA

- 12 m tall building
- Exposed expanded plastics storage in any portion of the warehouse
- Double- and multiple-row racks
## Water Demand Based on FM Ceiling Only Protection

### Water Demand for Exposed Expanded Plastic Commodities in Open-Frame Racks (l/s)

<table>
<thead>
<tr>
<th>Ceiling Height (m)</th>
<th>K161</th>
<th>K202</th>
<th>K242</th>
<th>K320</th>
<th>K363</th>
<th>K363&lt;sub&gt;EC&lt;/sub&gt;</th>
<th>K161</th>
<th>K202</th>
<th>K283</th>
<th>K363</th>
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<tbody>
<tr>
<td>2,4</td>
<td>57</td>
<td>92</td>
<td>90</td>
<td>120</td>
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<td>3,0</td>
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<td>90</td>
<td>120</td>
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<td>84</td>
</tr>
<tr>
<td>3,7</td>
<td>100</td>
<td>92</td>
<td>90</td>
<td>120</td>
<td>104</td>
<td>101</td>
<td>100</td>
<td>105</td>
<td>99</td>
<td>101</td>
</tr>
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<td>4,6</td>
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<td>120</td>
<td>104</td>
<td>121</td>
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<td>131</td>
<td>124</td>
<td>126</td>
</tr>
<tr>
<td>6,1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>104</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7,6</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>104</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9,1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>104</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10,7</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>104</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12,2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>275</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Developing New Protection Criteria

- Reduce water demand without in-rack sprinkler protection
- Well supported, standardized, and widely accepted
Approach

- Ceiling only protection
- Vertical barriers to slow horizontal fire spread
- 2.4 m aisles
- Large orifice, intermediate temperature sprinklers

- Considered enhanced in-rack sprinkler system
• Alternative Sprinkler System Designs for Storage
• Requires series of large scale fire tests
  – High clear/low clear
  – Ignition location relative to sprinklers
• Number of sprinklers used in the design must based on the worst-case result obtained in the full-scale fire test series increased by a minimum of 50%
  – Minimum of 12 sprinklers for standard coverage
  – 71 m² minimum operating area
• Criteria (Section A21.2)
  – Number of operated sprinklers
  – No sustained combustion at the outer edges of the target arrays
  – no sustained combustion at the far end of the main test array
  – no sprinklers should operate at the outer edges of the installed sprinkler system
  – 538°C (1000°F) maximum 1 minute average steel temperature measured above the fire
## Test Program

<table>
<thead>
<tr>
<th></th>
<th>Test A</th>
<th>Test B</th>
<th>Test C</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Storage Arrangement</strong></td>
<td></td>
<td></td>
<td>Double Row Rack</td>
</tr>
<tr>
<td><strong>Nom. Storage Height</strong></td>
<td>6,1 m</td>
<td>10,7 m</td>
<td>9,1 m</td>
</tr>
<tr>
<td><strong>Ceiling Height</strong></td>
<td></td>
<td></td>
<td>12,2 m</td>
</tr>
<tr>
<td><strong>Commodity</strong></td>
<td></td>
<td></td>
<td>Polystyrene Meat Trays on Hardwood Pallets</td>
</tr>
<tr>
<td><strong>Vertical Barriers</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Material</strong></td>
<td>Metal</td>
<td>Metal</td>
<td>9 mm Plywood</td>
</tr>
<tr>
<td><strong>Horizontal distance</strong></td>
<td>4,9 m</td>
<td>4,9 m</td>
<td>4,9 m</td>
</tr>
<tr>
<td><strong>Transverse Flue Spaces</strong></td>
<td>Blocked</td>
<td>Blocked</td>
<td>Open</td>
</tr>
<tr>
<td><strong>Aisle Width</strong></td>
<td></td>
<td></td>
<td>2,4 m</td>
</tr>
<tr>
<td><strong>Sprinkler</strong></td>
<td>ESFR K363 Intermediate Temperature (~100°C) at 4,1 bar</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Ignition Location</strong></td>
<td>Between 2 Sprinklers</td>
<td>Under 1 Sprinkler</td>
<td></td>
</tr>
</tbody>
</table>

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**Notes:**
- **Ignition Location:** Between 2 Sprinklers
- **Sprinkler:** ESFR K363 Intermediate Temperature (~100°C) at 4,1 bar
Test A: Setup
High Clearance
Ignited Between 2 Sprinklers
Test A: Damage
Test A: Sprinkler Activation

Image © 2012 Fire Protection Research Foundation
Test B: Damage - Target
Test B: Sprinkler Activation (10)

Image © 2012 Fire Protection Research Foundation
### Results Summary

<table>
<thead>
<tr>
<th></th>
<th>Test A</th>
<th>Test B</th>
<th>Test C</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Nom. Storage Height (m)</strong></td>
<td>6.1</td>
<td>10.7</td>
<td>9.1</td>
</tr>
<tr>
<td><strong>Transverse Flue Spaces</strong></td>
<td>Blocked</td>
<td>Blocked</td>
<td>Open</td>
</tr>
<tr>
<td><strong>Ignition Location</strong></td>
<td>Between 2 Sprinklers</td>
<td>Under 1 Sprinkler</td>
<td></td>
</tr>
<tr>
<td><strong>No. of Sprinklers Operated First – Last (min:sec)</strong></td>
<td>6 0:44 – 3:21</td>
<td>10 0:52 – 1:45</td>
<td>7 0:47 – 1:28</td>
</tr>
<tr>
<td><strong>Max. 1 minute avg. steel temperature (°C)</strong></td>
<td>47</td>
<td>61</td>
<td>53</td>
</tr>
<tr>
<td><strong>Ignition of Target</strong></td>
<td>None</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Extent of Fire Travel on Main Array</strong></td>
<td>1 bay beyond barrier</td>
<td>1 bay beyond barrier</td>
<td>1 pallet position beyond barrier</td>
</tr>
</tbody>
</table>
NFPA Standards Development Process

• Technical Committee reviews proposed revisions and public comments
  – Composed of experts from diverse interest groups

• First Draft
• Second Draft
• Certified Amending Motions
  – Voted on by membership
• Appeals
  – Voted on by Standards Council
• First Draft meetings in 2013
  – Published in Spring 2014
• Second Draft Meeting June 2014
  – Published by January 2015
• Certified Amending Motions
  – Hearing June 2015
• Final publication late 2015
Summary

• IKEA has taken a leading role in developing new sprinkler protection criteria
• Focused on providing a safe environment for coworkers and customers
• Technical support from the Fire Protection Research Foundations assists in addressing new fire protection challenges
• Relatively rapid NFPA code development cycles help to quickly address a changing fire hazard