Banded and Un-Banded Roll Paper Protection

Seth Sienkiewicz

FM Global Research
Outline

- Meeting Evolving Needs
- Roll Paper Hazard
- Mitigating the Hazard
- Large-Scale Fire Tests
- Conclusions
Meeting Evolving Needs

Natural Hazard Lab
- 70,000 ft²
- EQ Lab

Hydraulics Lab

Fire Technology Lab

Electrical Lab

Multimedia Center

Materials Lab

Improved Water Treatment Capacity

Test Staging Building

Large Burn Lab Improvements
- Movable Ceiling
- Humidity Control
Roll Paper Hazard

- **Characteristics**
  - Easily Ignitable
  - Extremely Fast Fire Growth
  - Intense Fire Plume

- **Contributors**
  - Storage Configuration
  - Paper Type/Weight
  - Exfoliation
Storage Configuration

Stack Height

Hazard

Stack Height
Storage Configuration

Hazard

Flue Size

Ignition Location

Primary Horizontal Flame Propagation

Standard Array

Open Array
Paper Weight

Hazards vs. Paper Weight

- Toilet paper
- Newspaper
- Brown paper

The graph shows a decrease in hazard with an increase in paper weight.
Exfoliation

- Provides Virgin Fuel
- Removes Pre-wetted Paper
- Spreads Fire to Adjacent Commodity
Mitigating the Hazard

- Stack Height
- Paper Type
- Flue Spaces
- Banding
Research Question

- Can rolls of heavyweight paper, butted in one direction, be protected the same regardless of whether or not they are banded?
Standard Array

All Stacks
Butted In N-S Direction

~24 ft
~19 ft
Ceiling Sprinkler Protection

- K115 Upright Sprinklers
- Standard Response
- Temperature Rating – 141°C
- Water Pressure – 1.0 Bar
- Discharge Density – 14 lpm
- Sprinkler Spacing – 3.0 m by 3.0 m
Evaluation Criteria

- No fire spread to the remote end of the array
- Number of sprinkler activations acceptable
- No excessive steel temperatures at ceiling
  - ≥1,000°F for 1 minute duration
  - ≥1,200°F instantaneous
Results

Banded

Un-Banded
Results: 1st Sprinkler Activation

Banded

Un-Banded
Results: ~3:30 min

Banded

Un-Banded
Results: ~7:00 min

Banded

Un-Banded
## Results

### FIRE TEST RESULTS

<table>
<thead>
<tr>
<th>Test ID</th>
<th>Banded</th>
<th>Un-Banded</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Sprinklers Opened</td>
<td>18</td>
<td>21</td>
</tr>
<tr>
<td>First / Last Sprinkler Operation Times (min:s)</td>
<td>1:29 / 3:32</td>
<td>1:10 / 3:44</td>
</tr>
<tr>
<td>Maximum One Minute Average Gas Temperature (°C) [°F]</td>
<td>1014 (1858)</td>
<td>959 (1759)</td>
</tr>
<tr>
<td>Maximum One Minute Average Steel Temperature (°C) [°F]</td>
<td>595 (1103)</td>
<td>631 (1168)</td>
</tr>
<tr>
<td>Total Chemical Energy Released (30 minutes) (GJ) [BTU\textsubscript{TH}]</td>
<td>4.69 (4448)</td>
<td>11.36 (10774)</td>
</tr>
<tr>
<td>Estimated Paper Consumed (kg) [lb]</td>
<td>335 (738)</td>
<td>812 (1790)</td>
</tr>
<tr>
<td>Test Termination - Time After Ignition (min:s)</td>
<td>30:00</td>
<td>30:00</td>
</tr>
</tbody>
</table>
Conclusions

- Equivalent Protection for Banded and Un-Banded
  - Standard Array
  - 6.4 m High Storage under a 9.1 m High Ceiling
  - 12 mm/min over 232 m²
- Structural Steel Protection Required
- Metal Bands Can be Removed from Standard Arrays without Protection Upgrade
- Allows Cost Savings and Alleviates Safety Concerns
Thank You

Questions?