Evaluating Fire Protection for Automatic Storage and Retrieval Systems

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ASRS Mini-Load Racks

- Dense storage
  - flue width
  - tier height
  - aisle width
- Fully automated
- Unique packaging
  - plastic totes
  - plastic containers
  - (un)cartoned
ASRS Fire Protection

- Minimal testing conducted with ASRS racks
- Current guidelines primarily based on testing with standard racks
- ASRS and standard rack geometry substantially different
Are These Equivalent?

Standard Rack

7.6 m

ASRS
Protection System Evaluation

- Compare ASRS and Standard Racks
  1) Standard racks using standard commodities
  2) ASRS racks using typical storage media (e.g. containers, trays)

  - Full scale testing prohibitively expensive and inefficient
Test Methodology
Test Methodology

- Evaluate segment of rack
- Fully replicate rack design
- Fire suppression water
  - Water uniformly applied to top
  - Simulated sprinkler response
- Measurements
  - Chemical heat release rate
  - Convective flow
Test Design

- Rack height of 7.6 m
- Double-row rack
- Center flue of 0.3 m
- Push back storage
- 672 containers
- Ignition at base
Evaluation Parameters

1. Fire growth dynamics
   - Free Burn

2. Suppression efficiency

![Graph showing heat release rate over time with lines for control and suppression, indicating suppression efficiency and fire growth dynamics.]

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Advantages

- Entire program expense equivalent to a single full-scale test
- Efficient setup and clean up

- Potential link to full-scale data
  - Historic data with standard racks
  - Viability of ceiling sprinkler protection
Limitations

- Simulated sprinkler system
  - Water application rates not equivalent to sprinkler density
  - Requires large-scale validation
- Results not applicable to in-rack sprinkler systems
- Aisle jump not considered
Standard Commodities

1) CUP: cartoned unexpanded plastic
2) CEP: cartoned expanded plastic
3) UUP: uncartoned unexpanded plastic
4) UEP: uncartoned expanded plastic
Standard Rack with UUP
UUP (Plastic Pallets)

Chemical Heat Release Rate (kW) vs. Time (s)

- Water application
- 41 mm/min
- 51 mm/min
- 61 mm/min
ASRS Rack with Containers
Covered Containers

Chemical Heat Release Rate (kW) vs Time (s)

- Water application
- 41 mm/min
- 53 mm/min
- 73 mm/min

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Data Comparison, ~53 mm/min
Testing Progress

- Completed, ASRS:
  - Open-top plastic containers
  - Covered plastic containers

- Remaining, ASRS:
  - CUP stored on plastic trays
Preliminary Comments

- **Flammability**
  - ASRS and standard racks exhibit similar fire growth rates

- **Suppression**
  - ASRS increases water demand
  - Limited water penetration

- **Ceiling sprinkler protection for standard racks cannot be applied**
Open-top Containers
Questions?