NARA-Sponsored Research in Records Fire Suppression

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Why does NARA conduct fire tests?

- 1973 National Personnel Records Center fire
- Records fires do not behave like commodity fires.
- Lack of National Standards intended to protect ***contents***
- Technology advances
- Risk management / cost-benefit

Contact

For further information or copies of NARA-sponsored fire test reports:

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Conventional Records Center Shelving Fire Tests

- 1974 Factory Mutual - three tests
- 1980 Factory Mutual - three tests
- 1999 Southwest Research Institute - one test

1974 Factory Mutual Tests

Standard 14-high shelves, standard 280°F sprinklers on 10’ x 10’ grid, 0.30 gpm per sq. ft.

- First test, no catwalk, exfoliating records
  - Smoke detection at 25 seconds
  - 8 sprinklers operated: 5 min. 11 sec. to 5 min. 52 sec.
  - 50 cubic feet destroyed

1974 Factory Mutual Tests

Standard 14-high shelves, standard 280°F sprinklers on 10’ x 10’ grid, 0.30 gpm per sq.. ft.

- Second test, catwalk at 7’ - 1”, exfoliating records
  - Smoke detection at 16 seconds
  - 16 sprinklers operated: 5 min. 58 sec. to 12 min. 52 sec.
  - 240 cubic feet destroyed

1974 Factory Mutual Tests

Standard 14-high shelves, standard 280°F sprinklers on 10’ x 10’ grid, 0.30 gpm per sq. ft.

- Third test, catwalk at 7’ - 1”, no exfoliating records
  - Smoke detection at 33 seconds
  - First sprinkler operated at 19 min. 13 sec.
  - Second sprinkler operated at 19 min. 43 sec.
  - Third (final) sprinkler at 44 min. 29 sec.
  - 20 cubic feet destroyed

1974 Factory Mutual Tests

Lessons Learned:

- Smoke detectors can provide meaningful early warning
- Exfoliation adds significantly to fire development
- Catwalks under exfoliating records reduce sprinkler effectiveness
- Standard sprinklers may not protect roof structures

1980 Factory Mutual Tests

Standard 14-high shelves, Large Drop 280°F sprinklers on 10’ x 10’ grid, 0.56 gpm per sq. ft. (No smoke detector data)

- First test, no catwalk, paper only
  - First - third sprinklers operated at 3 min. 32 sec.
  - Fifth (final) sprinkler operated at 3 min. 53 sec.
  - 142 cubic feet destroyed

1980 Factory Mutual Tests

Standard 14-high shelves, Large Drop 280°F sprinklers on 10’ x 10’ grid, 0.56 gpm per sq. ft. (No smoke detector data)

- Second test, no catwalk, computer tape and paper
  - First sprinkler operated at 6 min. 16 sec.
  - Fourth (final) sprinkler operated at 6 min. 34sec.
  - 237 cubic feet destroyed

1980 Factory Mutual Tests

Standard 14-high shelves, Large Drop 280°F sprinklers on 10’ x 10’ grid, 0.56 gpm per sq. ft. (No smoke detector data)

- Third test, catwalk at 7’ - 1”, computer tape and paper
  - First sprinkler operated at 3 min. 40 sec.
  - Eighth (final) sprinkler operated at 4 min. 29sec.
  - 285 cubic feet destroyed

1980 Factory Mutual Tests

Lessons Learned:

- Plastics greatly increase speed and extent of fire development
- Large drop sprinklers offer superior roof joist protection compared to standard sprinklers

1999 SwRI Test

- 29-high shelving
- Catwalks at 16 ft 3 in and 24 ft 6 in
- 155°F QR sprinklers on 7-foot centers under catwalk
- 286°F standard sprinklers on 10’ X 10’ grid at ceiling
- Smoke detection at 1 min. 20 sec.
- Controlled by single sprinkler at 2 min. 51 sec.
- 40 cubic feet destroyed

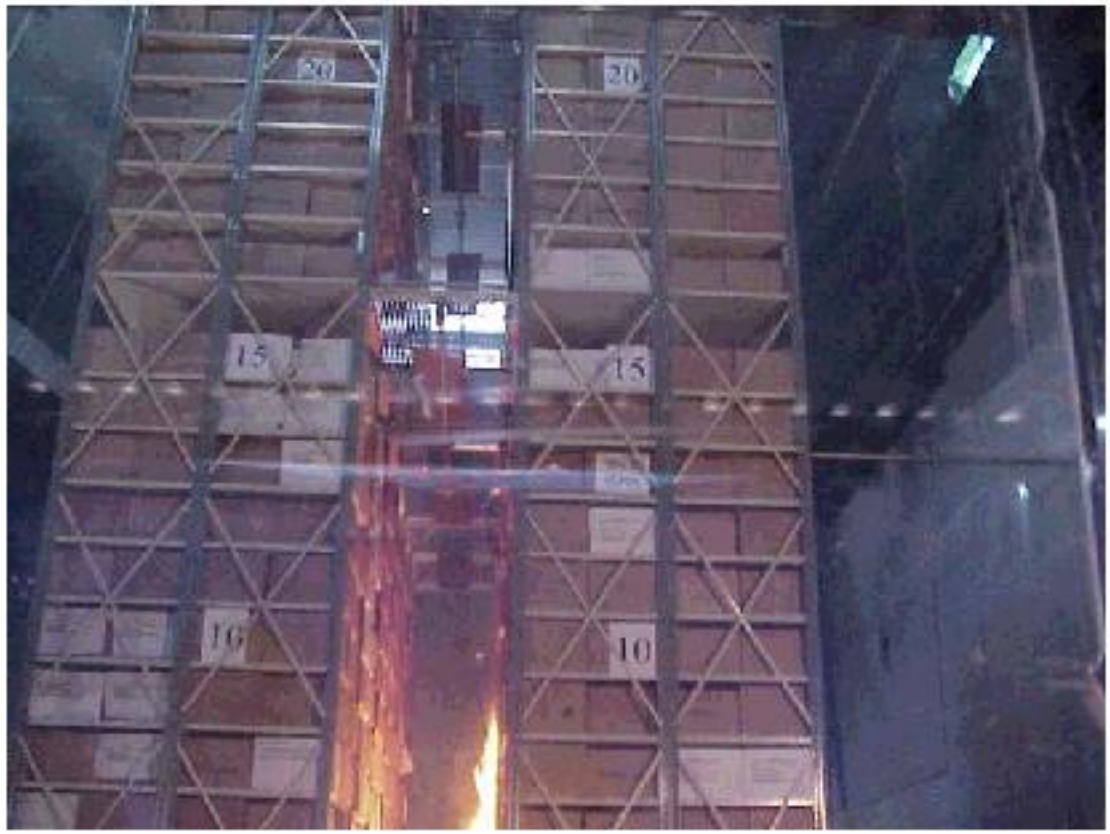
Commodity Array

Fire Ignition at 0:04

Initial Fire Development 1:16

Growth up initial face 1:32

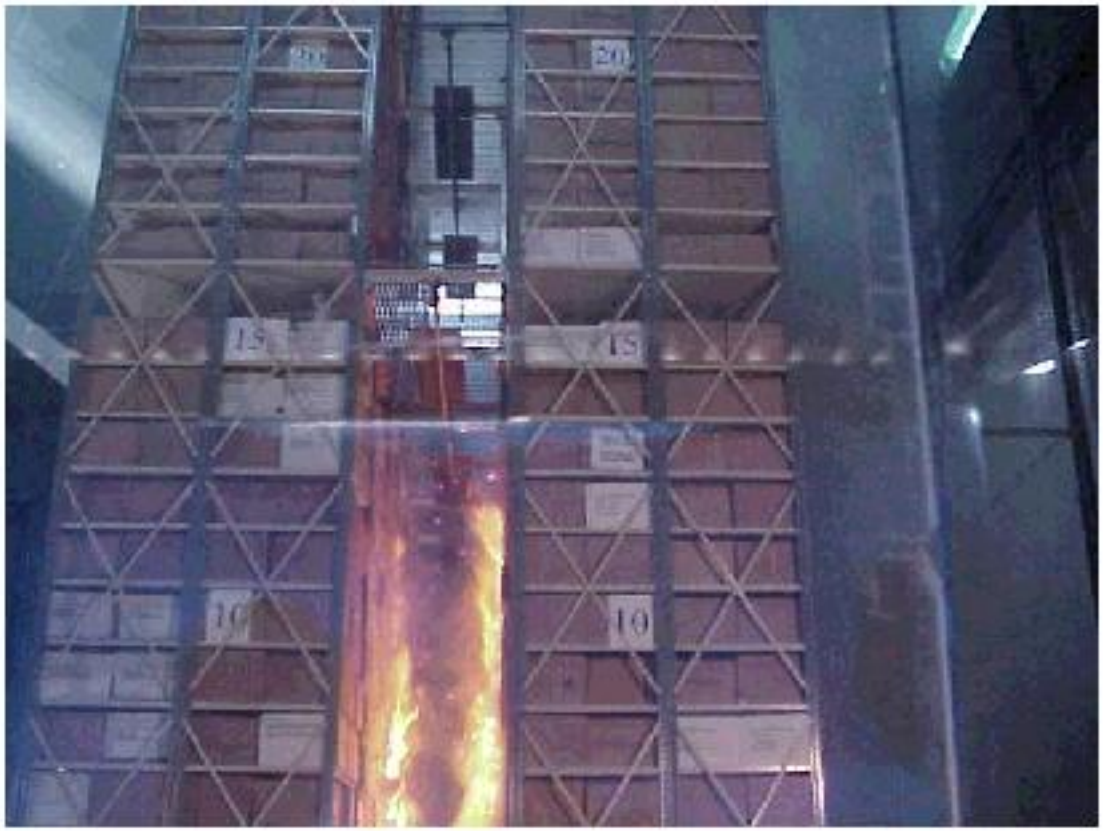
Fire near first catwalk, 1:46



Fire crosses aisle, 2:16

Second face involved, 2:28

Fire at catwalk level, 2:42



Just before sprinkler activates, 2:48

Sprinkler activated, 3:46

Containment begins, 4:44

Exfoliation pile

Center aisle

1999 SwRI Test

Lessons Learned:

- Effective protection can be achieved in high-shelf arrays
- 155°F QR sprinklers activate much quicker than standard sprinklers.
- Beginning salvage/overhaul earlier would have further reduced loss

The "Unplanned" Tests

- Three arson events at the Washington National Records Center, Suitland, MD
  - Real fires slower to develop
  - Real effectiveness of sprinkler systems match test results
  - Demonstrates role of training for the Fire Departments

Recommendations: Conventional Shelving Arrays*

- Suppression systems should be professionally designed to meet specific performance criteria
- Faster is better:
  - "QR" sprinklers more effective than standard response
  - Lower temperature ratings may reduce extent of water damage
  - Reduced coverage per sprinkler (100 square feet versus normal 130 square foot)
- Use smoke detection in high value collections

* Applies to new construction & major renovations only

Compact Shelving Tests

- 1978 Factory Mutual -- 3 Tests
- 1989 Underwriters Laboratories -- 2 Tests
- 1996 Underwriters Laboratories -- 2 Tests

1978 FM Tests: Compact Shelving

- Mobile (compact) shelving, 7 high, standard 280°F sprinklers on 10’ x 10’ grid, 0.30 gpm per sq. ft., solid steel partition between sections
  - First test: 8 Hollinger boxes per shelf, solid face; fire started at standard 42” aisle
    - Smoke detection at 5 min. 26 sec.
    - 3 sprinklers activated: 17 min. 30 sec. to 19 min. 46 sec.
    - 170 cubic feet destroyed

1978 FM Tests: Compact Shelving

- Mobile (compact) shelving, 7 high, standard 280°F sprinklers on 10’ x 10’ grid, 0.30 gpm per sq. ft., solid steel partition between sections
  - Second test: 8 Hollinger boxes per shelf, with occasional boxes removed; fire started in center of closed array
    - Smoke detection at 16 min. 44 sec.
    - 4 sprinklers activated: 1hr 32 min to 1 hr 39 min
    - 850 cubic feet destroyed

1978 FM Tests: Compact Shelving

- Mobile (compact) shelving, 7 high, standard 280°F sprinklers on 10' x 10' grid, 0.30 gpm per sq. ft., solid steel partition between sections
  - Third test: 7 Hollinger boxes per shelf, significant quantity of computer tapes added; fire started in center of closed array
    - Smoke seen at ceiling at 12 min. 45 sec.
    - 1st. sprinkler activated at 48 min; 2nd at 1 hr. 18 min; 3rd at 2 hr. 1 min.; final at 2 hr. 5 min.
    - 1460 cubic feet destroyed

1978 FM Tests: Compact Shelving

Lessons Learned:

- Standard 280°F sprinklers not effective in preventing major loss of records
- Occasional missing boxes had little effect, but loose packing the entire array increased fire severity
- Books, plastics increased fire severity
- Fire at aisle resulted in more rapid fire development, but also caused more rapid activation of sprinklers.

1990 UL Tests: Compact Shelving

- Mobile (compact) shelving, 7 high, 165°F QR sprinklers on 10’ x 10’ grid, 0.30 gpm per sq.ft.; solid steel partition between sections, vertical steel partition within row. Seven Hollinger boxes per shelf.
- Test 1: Tested new “Fire Park” mode, interior fire, similar to 1978 FM Test 3
- Test 2: Identical to 1978 FM Test 1 except for type of sprinkler used and within row steel partition, fire at aisle

1990 UL 1 vs. 1978 FM 3

1990 UL 1

- Smoke detected at 1m27s
- 3 sprinklers between 1m35s and 3m40s
- Virtually no loss

1978 FM 3

- Smoke detected at 12m45s
- 4 sprinklers between 48 min and 2h5m
- 1460 cubic feet lost

1990 UL 1 vs. 1978 FM 3

Lessons Learned:

- Combination of 165° F "QR" sprinklers and "Fire Park" extremely effective
- Solid steel top shelf cover created a water curtain that enhanced the control over both the vertical and horizontal fire spread.

1990 UL 2 vs. 1978 FM 1

1990 UL 2

- 1 sprinkler at 12m45s
- Fire did not jump aisle
- Max ceiling temp: 700°
- Under 20 cubic feet lost

1978 FM 1

- 3 sprinklers between 17m30s and 19m46s
- Fire jumped aisle
- Max ceiling temp: 1000°
- 170 cubic feet lost

1990 UL 2 vs. 1978 FM 1

Lessons Learned:

- "QR" sprinkler reacted significantly sooner, controlled fire with just one sprinkler
- In-row vertical steel partition prevented horizontal spread of fire

1996 UL Tests: Compact Shelving

- Test 1 similar to 1990 Test 1
  - Both used 160° F QR sprinklers at 0.30 gpm/ft^2
  - Both used "Fire Park" mode
  - 1996 Test at 8 high vs. 7 high in 1990
  - 1996 Test 1 had high concentration of plastics (42 computer tapes per shelf) on some units

1996 UL Tests: Compact Shelving

- Test 2 changed:
  - Reduced flow rate from 0.30 gpm/ft^2 to 0.20
  - Total plastics reduced from 8% to 5%
  - Plastic per shelf limited to 7 tapes

1996 UL 1 vs. 1990 UL 1

1996 UL 1

- Smoke detected at 1m45s
- 3 sprinklers between 4m39s and 9m30s
- Less than 100 ft^3 loss

1990 UL 1

- Smoke detection at 1m27s
- 3 sprinklers between 1m35s and 3m40s
- Virtually no loss

1996 UL 1 vs. 1996 UL 2

1996 UL 1

- Smoke detected at 1m45s
- 3 sprinklers between 4m39s and 9m30s
- Less than 100 ft^3 loss

1996 UL 2

- Smoke detection at 2m12s
- 4 sprinklers between 3m34s and 5m55s
- Less than 50 ft^3 loss

1996 UL Tests: Compact Shelving

- Lessons Learned:
- Adding 8th shelf did not significantly reduce effectiveness
- Concentrations of plastics in compact shelving should be avoided
- Reducing the flow rate did not significantly reduce effectiveness

Recommendations: Compact Shelving Systems

- Use ordinary temperature “QR” sprinklers
- Use “Fire Park” mode for large arrays
- If not practical to use “Fire Park” mode, use vertical barriers in every third row
- Always cover the top shelf with solid steel canopies.
- Limit concentration of plastics in compact shelving systems

Computer modeling, "QR"

"QR" Sprinkler Head

- Temp. rating: 165°F
- Response time: 198 sec
- Heat release at time of activation: 348 KW

Standard Sprinkler Head

- Temp. rating: 165°F
- Response time: 252 sec
- Heat release at time of activation: 695 KW

DETACH - T2, developed by NIST

Fire Test Summary

- Fire suppression is a ***total system***, not just sprinklers
- The solid steel shelves are an essential component
- The NARA risk management objective of limiting loss from a single fire event to less than 300 ft^3 can economically be achieved in a variety of shelving formats
- Sprinklers contain, but do not extinguish, records fires

Role of Security in Disaster Prevention

Prevention

Mitigation

Prosecution

- All of the significant real fires at NARA have been arson

- The five most recent disasterous commercial records center fires have been arson

Prevention

- Control access to the stacks
  - Locking systems
  - Intrusion Detection
  - CCTV
  - Avoid windows in stacks
  - Personnel checks

Mitigation

- Match the system to the risk management objective
  - Choice of agents
  - Responsiveness
- Monitor and supervise the system
- Compartmentalization: when everything else fails
- Recovery preparedness

Prosecution

- Who had access?
  - How do you know?
    - Access control systems
    - CCTV
    - Supervisory logs
  - Motive

Conclusion

- Establish risk management objectives
- Implement a professionally-designed total system based on performance objectives
- Risk can be managed, but it cannot be avoided.

Standards and Regulations

NFPA 232-2000: Standard for the Protection of Records

- ANSI-adopted Standard
- 2000 revision established mandatory coverage of archives and records centers
- Currently under review: see www.nfpa.org

36 CFR 1228, Subpart K: Facility Standards

- Applies only to Federal records storage
- Sets minimum standard for all Federal records