

Analysis of Sprinkler Design Criteria for High Air Movement Areas

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Challenges of High Air Movement Areas

- Irregular smoke movement
- Temperature redistribution
- Detection
- Sprinkler activation
- Additional damage

Design Considerations

- NFPA 13
 - Roof vents
 - Cleanrooms
 - Residential ceiling fans
 - Obstruction vs. activation
- NFPA 72
 - Smoke detectors in high air movement areas
 - Residential ceiling fans



Design Considerations

- Questions from the practicing engineer
 - Should fast response sprinklers be used?
 - If so, should the area modification permitted by NFPA 13 be used?
 - Should the protection area be decreased?
 - Should the design density be increased?
 - Should the area of operation be increased?
 - What is the impact of velocity on
 - RTI?
 - Ability of the ceiling jet to reach the sprinkler?
 - Ability of the sprinkler to control the fire?
 - Sprinkler distribution pattern?

Instances of High Air Movement

- Cleanrooms
- Coal mine operations
- HVLS Fans

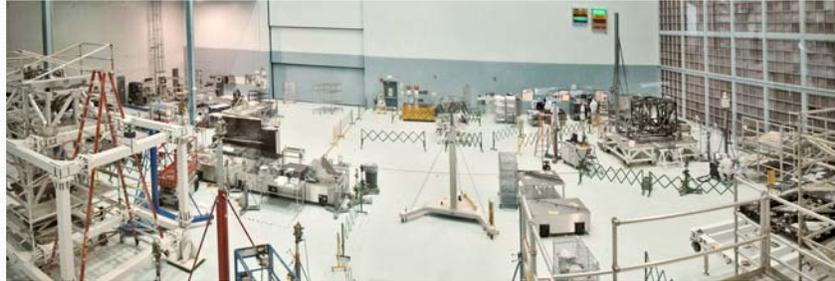
Cleanrooms

- High air velocity
- Limited Particle Size
- Frequent Air Changes
- Downward Air Flow



Importance of Protecting Cleanrooms

- Expensive equipment
- Irreplaceable research
- Valuable resources
- Flammable and combustible materials



NASA Cleanroom

Challenges of Cleanrooms

- Downward air flow
- Temperature profiles
- Delayed sprinkler activation



HEPA
filter

Cleanrooms: Code analysis

- NFPA 318: Standard for the Protection of Semiconductor Fabrication Facilities
 - Requires quick response sprinklers
- NFPA 13: Standard for the Installation of Sprinkler Systems
 - Higher density
 - Larger area of operation



Cleanrooms: Code Analysis Detection Strategies

- NFPA 75: Standard for the Protection of Information Technology Equipment
 - Recommends air sampling detection
- NFPA 72: National Fire Alarm Code
 - Detector placement
 - Maximum air velocity for smoke detectors



Coal Mine Operations

- High air velocity along conveyor belts
- 25 fires over 9 years
- Mine Safety and Health Administration investigation



Challenges of Coal Mine Conveyor Belts

- Friction
- Fuel Supply
- Suppression



MSHA Sprinkler Activation Investigation

- Sprinklers tested at upper and lower air velocity limits
 - .5 m/s, 5.1 m/s
- At upper velocity limit:
 - Delayed activation
 - Irregular activation locations
 - Increased fire size



MSHA Conclusions

- Fire not effectively suppressed
- Additional research will be completed



HVLS fans

- High volume air movement
- Large, highly efficient fans
- Used in warehouses and manufacturing facilities
- Generates air velocities up to 4.5 m/s



Challenges of HVLS Fans

- Sprinkler spray patterns
- Activation



Fire Protection Research Foundation Investigation: Phase 1

- Concerns about effects of HVLS fans on sprinkler discharge:
 - Blades obstruct discharge
 - Change in sprinkler spray patterns
- Did not cause test failure



Fire Protection Research Foundation Investigation: Phase 2

- Impact of large airflows on sprinkler RTI
- Hot gas and fire plume redistribution
- Delayed sprinkler activation
- Smoke and flame spread amplified
- Multiple sprinkler activations



Investigation Conclusions

- Interlocking sprinkler and fan systems
 - Cease HVLS fan operation with water flow alarm
 - Fans shut down within 1 minute and 30 seconds of sprinkler activation
- Interlocking air sampling detection and fan systems
 - Not as cost efficient

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Conclusions

- High air movement causes:
 - Increased fire size
 - Delays in sprinkler activation
 - Changes in location of sprinkler activation
- Sprinkler design requires creative solutions specific to area