



FSSA

Fire Suppression Systems Association

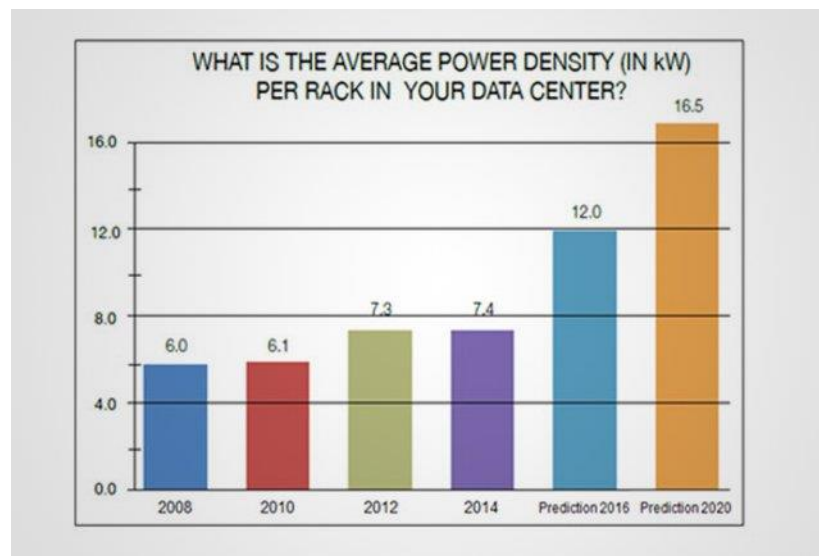
Fire Protection for Hot and Cold Aisle Containment Systems in Data Centers

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VP Engineering
ORR Protection

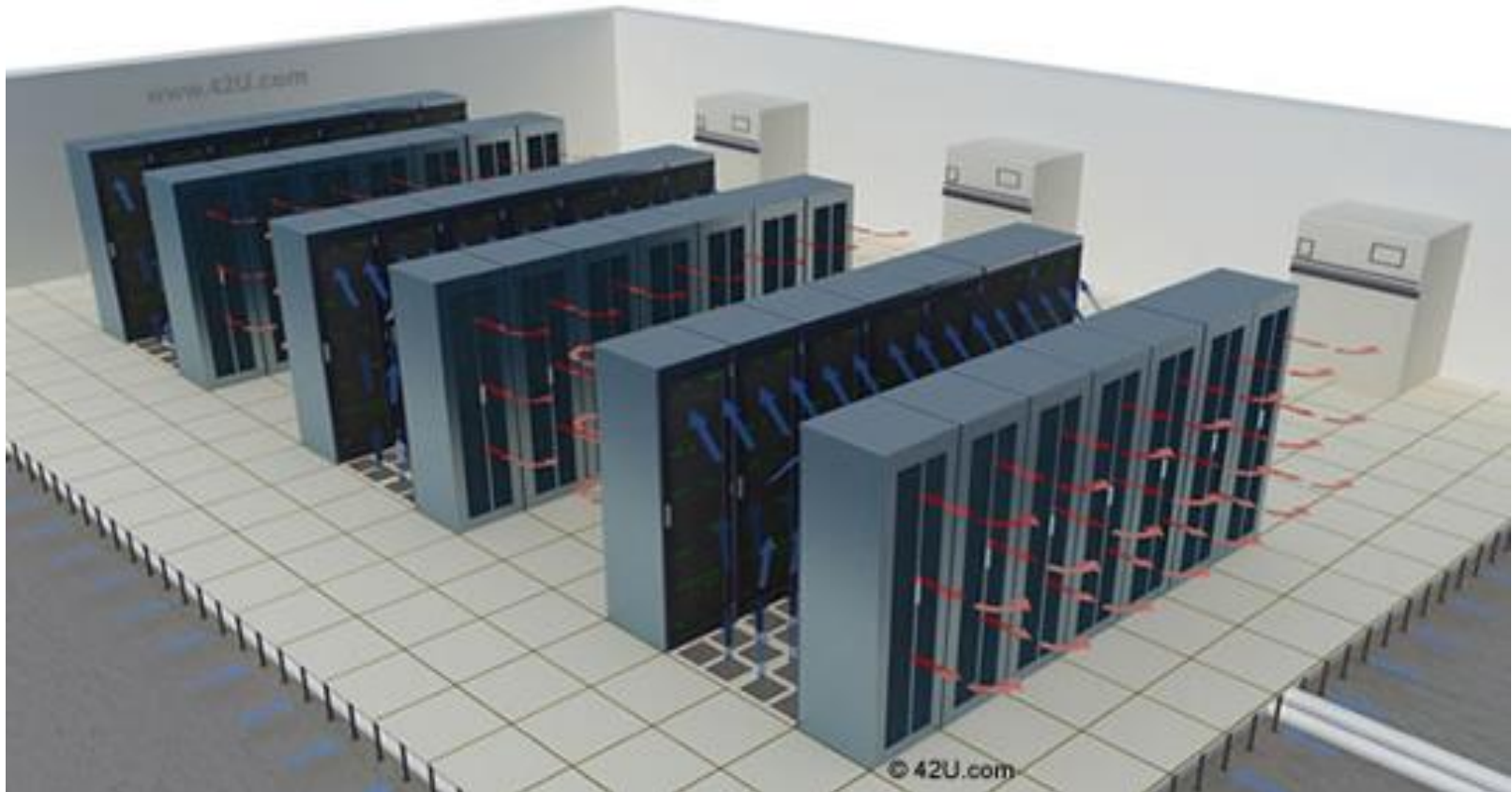


New Conditions in Data Centers

- Significantly higher rack power densities
 - Saves on facility space
 - Supports new technologies
 - Contributes to reduced energy costs
- New cooling technologies
 - Supports high density computing
 - Improves cooling efficiencies
- Challenging the performance of fire protection systems

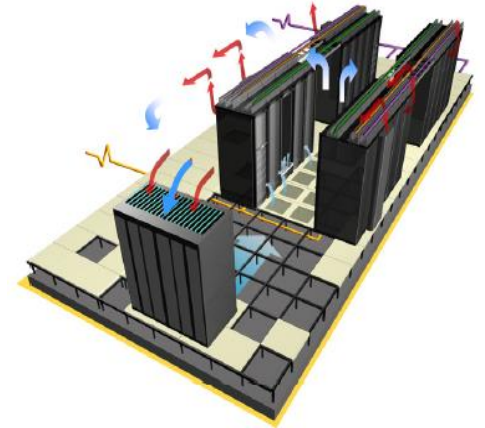


Hot Aisle / Cold Aisle Layout

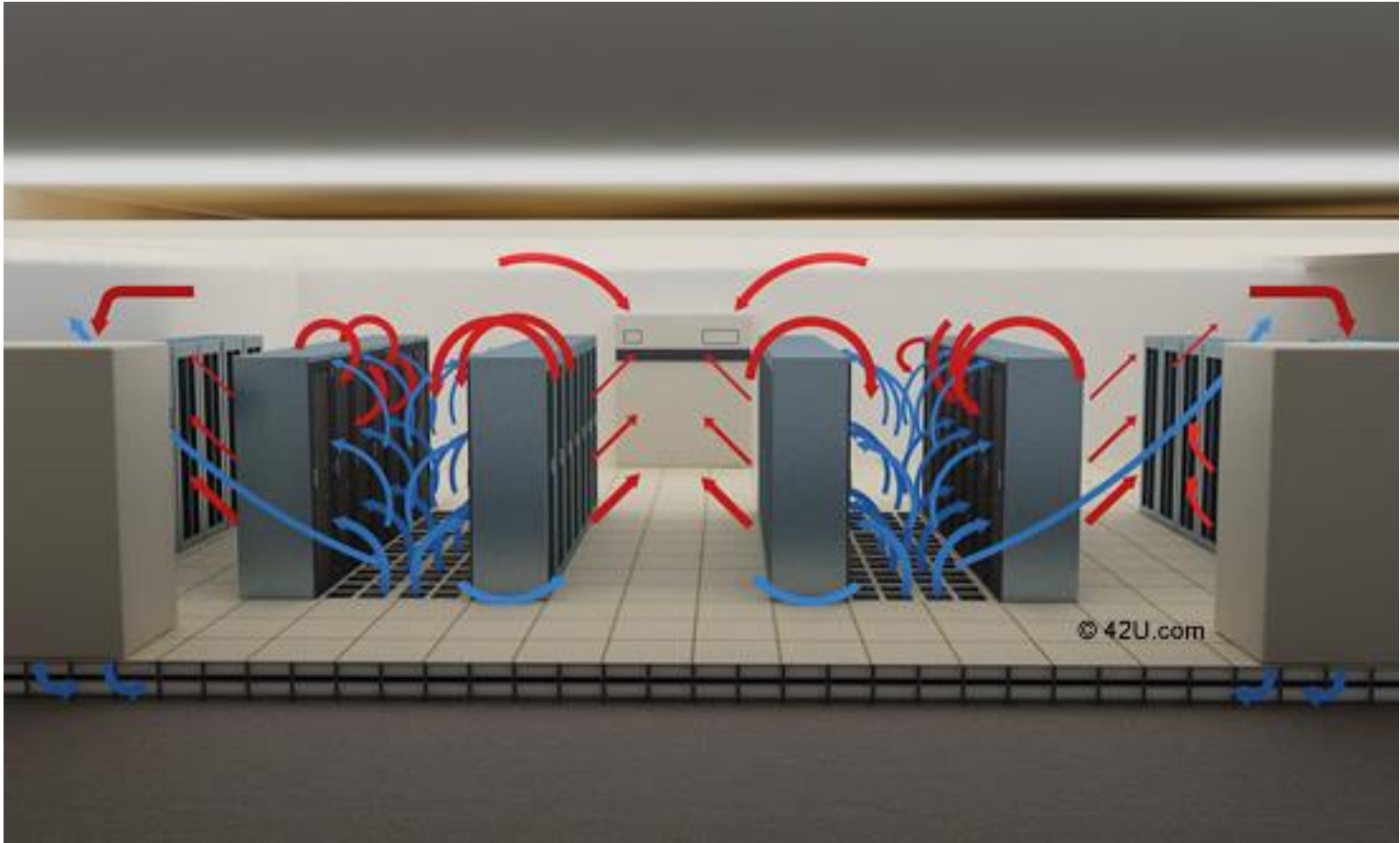


Cooling the Data Center

- Traditional Cooling Approach
 - Hot and cold air mix
 - Requires lots of energy to cool large volume of air
- Hot Aisle/Cold Aisle Containment Systems
 - “Contain” the air using partitions
 - Separate cool supply air from warm exhaust air
 - Increase cooling energy efficiency



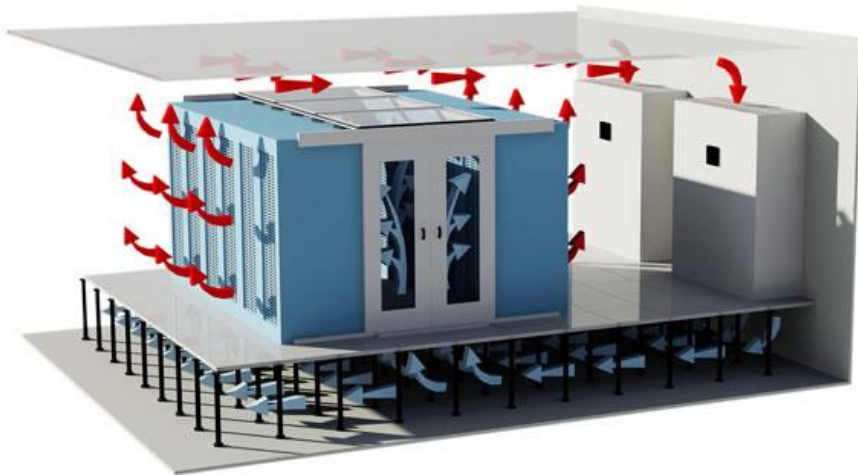
Hot Air Bypass



Cooling the Data Center

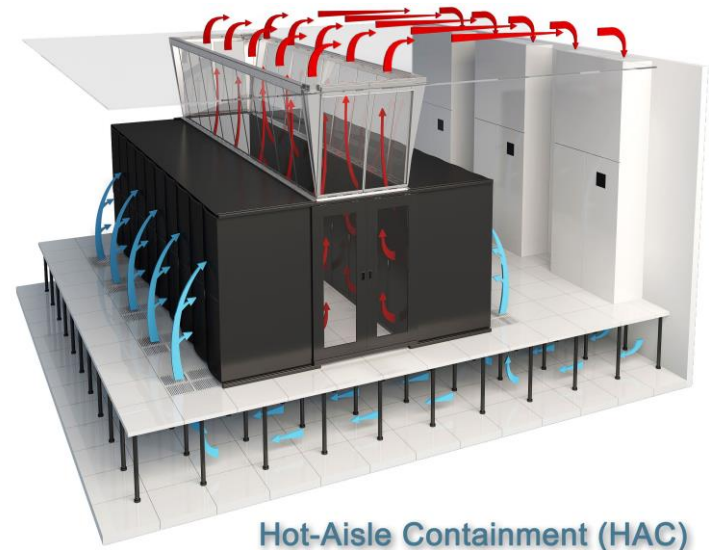
Cold Aisle Containment Systems

- Position rows with “fronts” facing each other
- Enclose the cold aisle
- Draw cold air from shared aisle



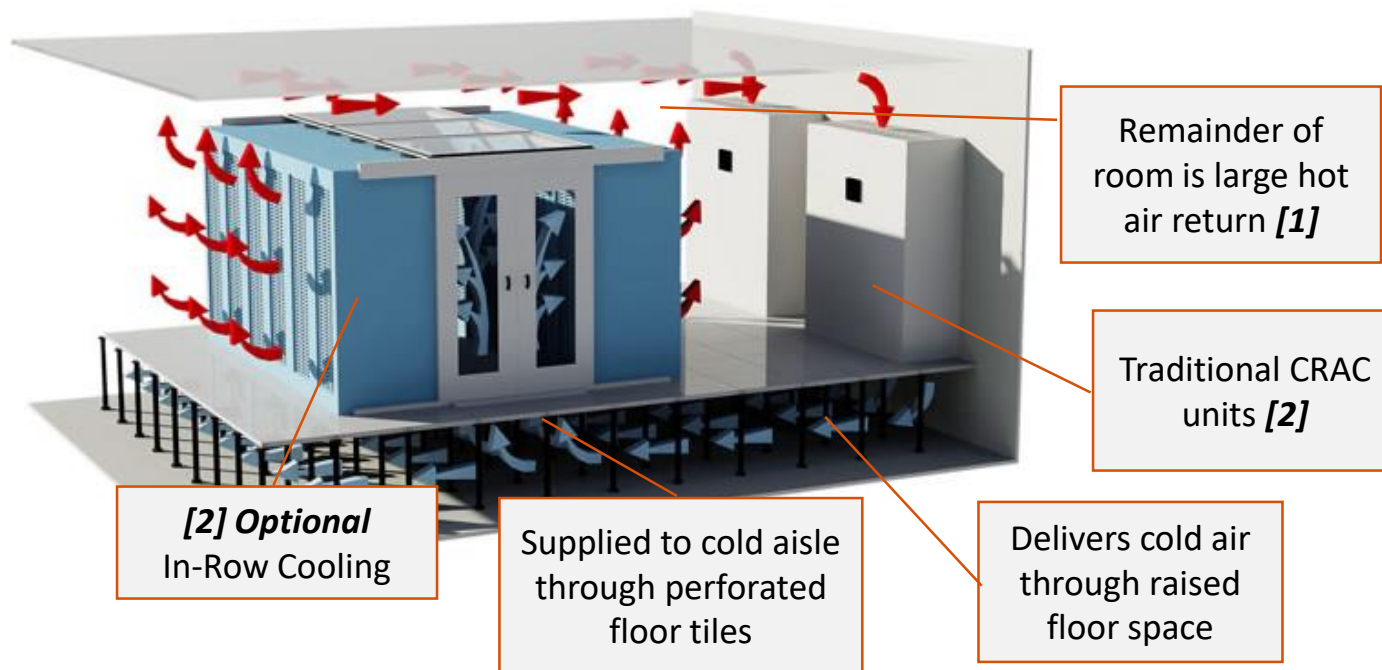
Hot Aisle Containment Systems

- Position rows with “rears” facing each other
- Enclose the hot aisle
- Exhaust hot air to ceiling plenum



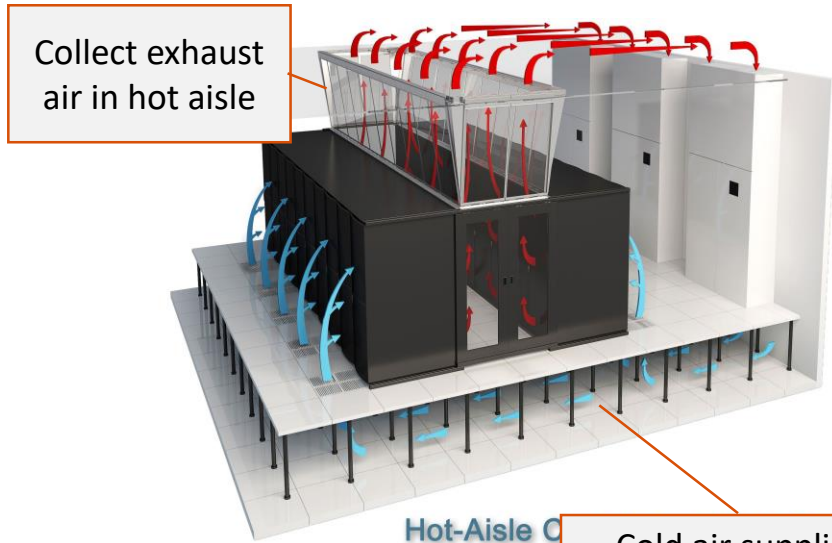
Typical Designs

Cold Aisle Containment Designs

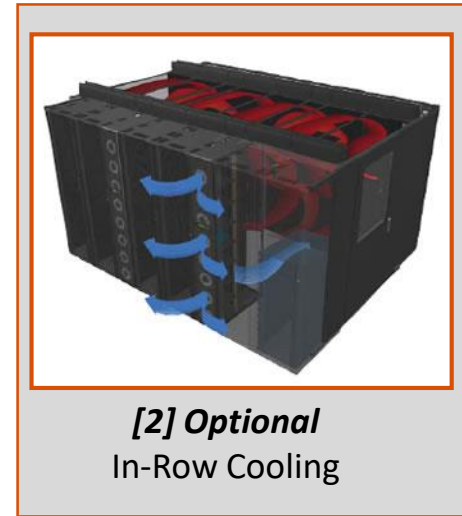


Typical Designs

Hot Aisle Containment Designs

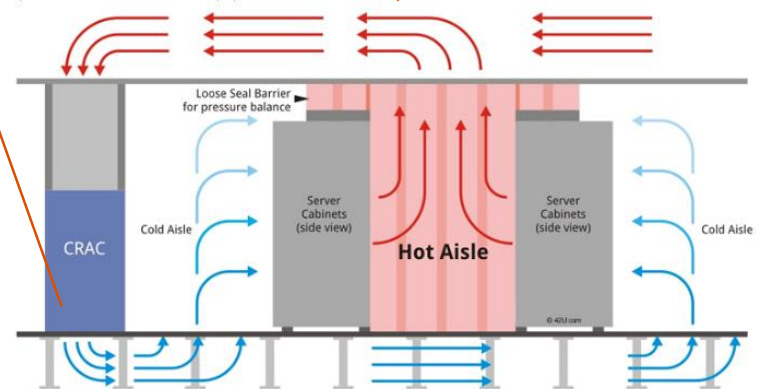


Cold air supplied through perforated floor tiles



Traditional CRAC units [2]

Warm air conveyed to return air plenum



Many different approaches...

Fixed infrastructure systems

- Attach ceiling panels and end-doors to racks
- Commonly referred to as “Pods”



Plastic Curtains

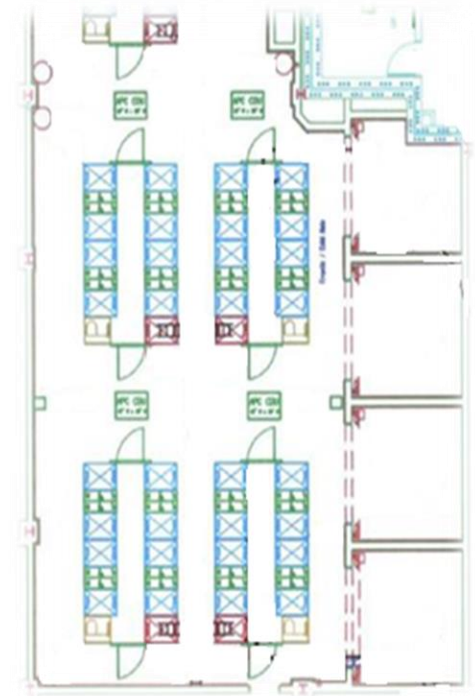
- Attach to ceiling
- Extends to top of racks or floor



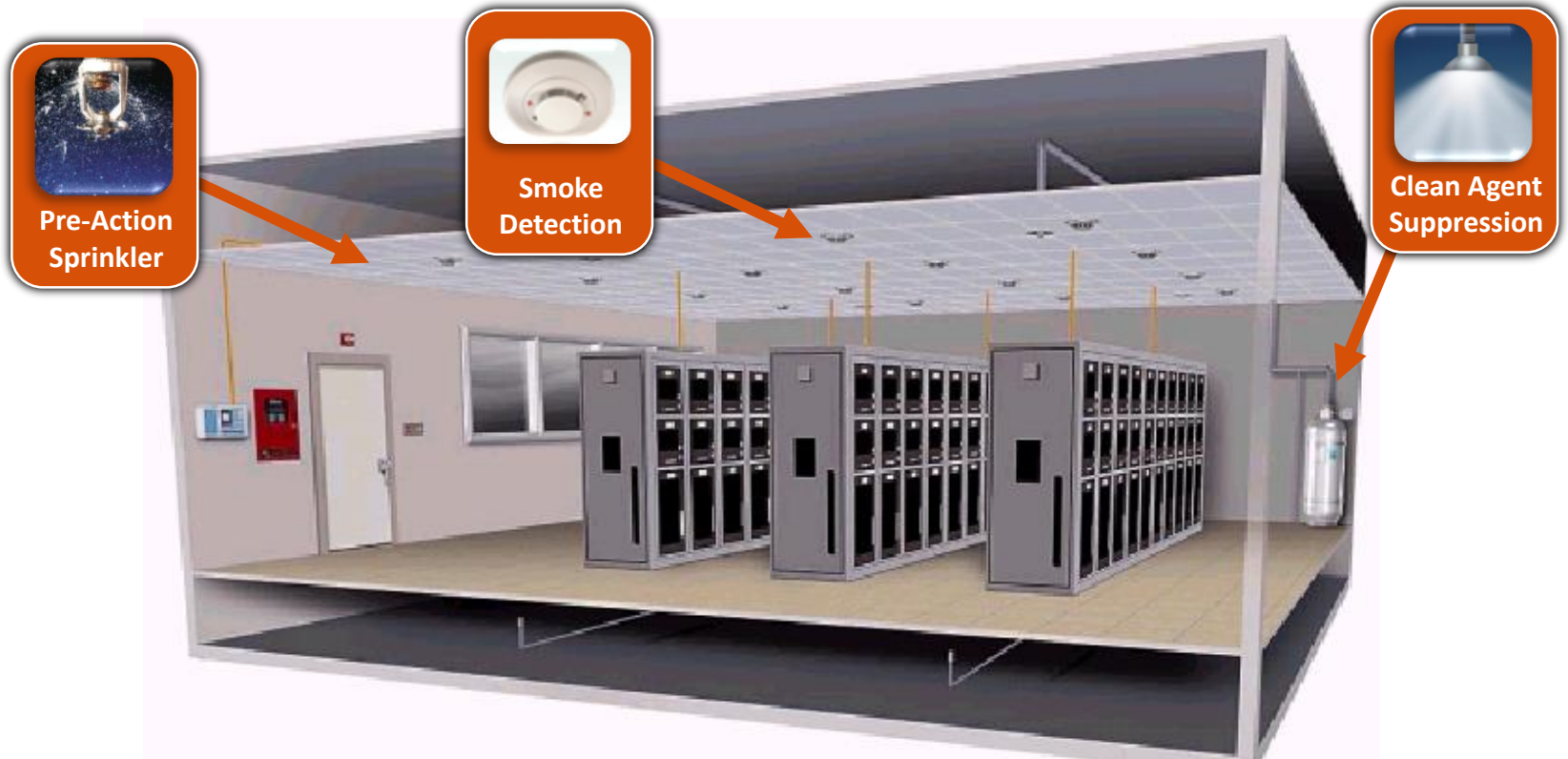
Many different approaches...

Aisle containment may be...

- ✓ Included in initial design
- ✓ Retrofitted to existing data center
- ✓ Modified over life of data center



Fire Protection in the Data Center



5 Fire Protection Challenges

Challenge #1: Obstructions

Obstructions impact...

- ❑ Sprinkler spray patterns
- ❑ Smoke detection coverage and spacing
- ❑ Clean Agent nozzle clearance and coverage



5 Fire Protection Challenges

Challenge # 1: Obstructions

Sprinkler spray patterns...

□ NFPA 13 Requirements

- ✓ Figure A.8.5.5.1
- ✓ Fixed obstructions > 4 ft.

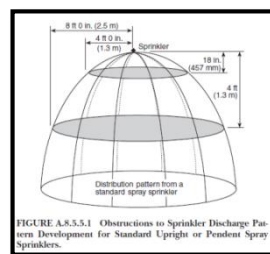
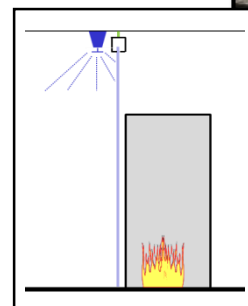


FIGURE A.8.5.5.1 Obstructions to Sprinkler Discharge Pattern Development for Standard Upright or Pendant Spray Sprinklers.



NFPA 13 - 2019 Edition

9.5.5 Obstructions to Sprinkler Discharge.

9.5.5.1* Performance Objective. Sprinklers shall be located so as to minimize obstructions to discharge as defined in 9.5.5.2 and 9.5.5.3, or additional sprinklers shall be provided to ensure adequate coverage of the hazard. (See Figure A.9.5.5.1.)

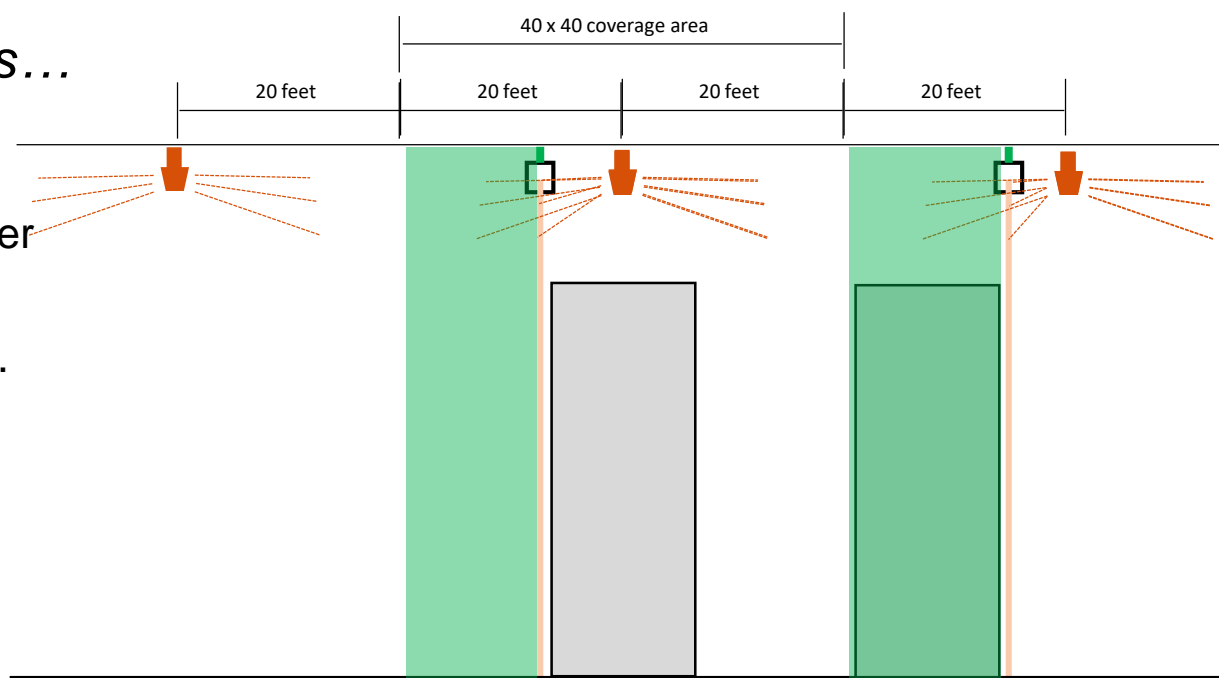
5 Fire Protection Challenges

Challenge # 1: Obstructions

Clean agent nozzles...

□ Coverage Area

- ✓ System manufacturer requirements
- ✓ Typical 40 ft. x 40 ft.



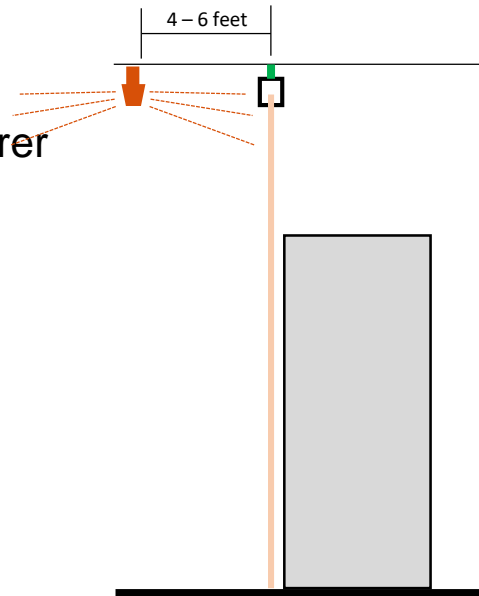
5 Fire Protection Challenges

Challenge # 1: Obstructions

Clean agent nozzles...

□ Clearance

- ✓ System manufacturer requirements
- ✓ 4 to 6 ft. clearance



Example Manufacturer Design Manual:

Walls and Obstructions:

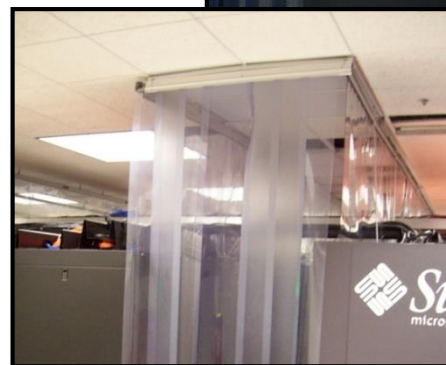
<Agent> discharged from the nozzle requires a certain length from the nozzle to atomize into a gas. If the <Agent> comes into contact with a surface before the agent is fully atomized, frosting can occur. As a result, the concentration throughout the enclosure will be less than required to appropriately protect the space. Therefore, nozzles must be located with at least four to six feet of clearance from walls and/or significant obstructions (ex. high rise racking and columns). If this requirement cannot be met, additional agent may be discharged to compensate for this agent "loss".

5 Fire Protection Challenges

Challenge # 2: Inadequate automatic obstruction removal

Impacts...

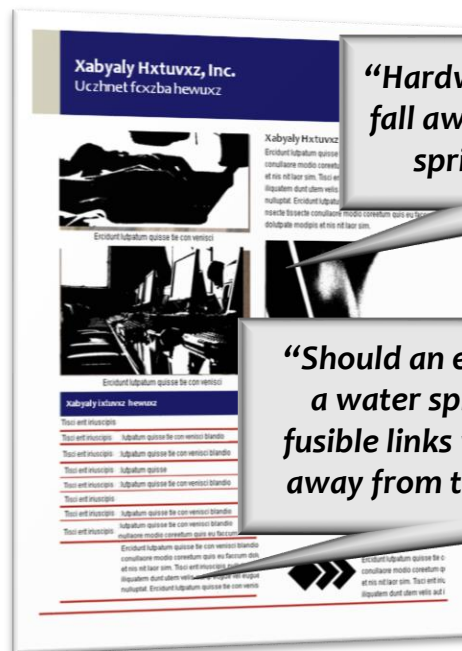
- ❑ Sprinkler spray patterns
- ❑ Clean agent nozzle clearance and coverage
- ❑ Clean agent concentration development



5 Fire Protection Challenges

Challenge # 2: Inadequate automatic obstruction removal

What does the product literature say about Fire Protection?



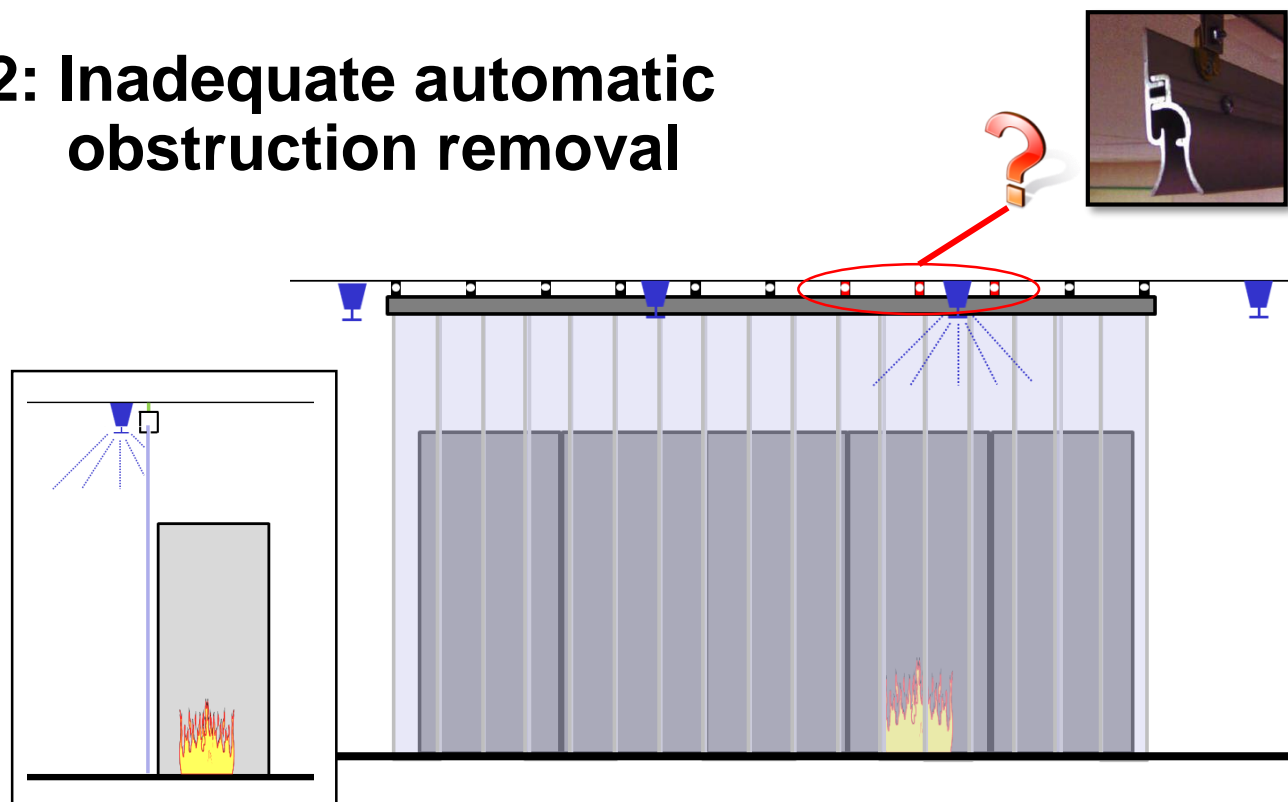
“Hardware is designed so that curtains fall away in the case of a fire, allowing sprinklers full operating range.”

“Should an event occur that would set off a water sprinkler system, the UL listed fusible links will melt... will fall harmlessly away from the ceiling down to the floor.”

5 Fire Protection Challenges

Challenge # 2: Inadequate automatic obstruction removal

Will there be reliable and adequate removal prior to sprinkler operation?

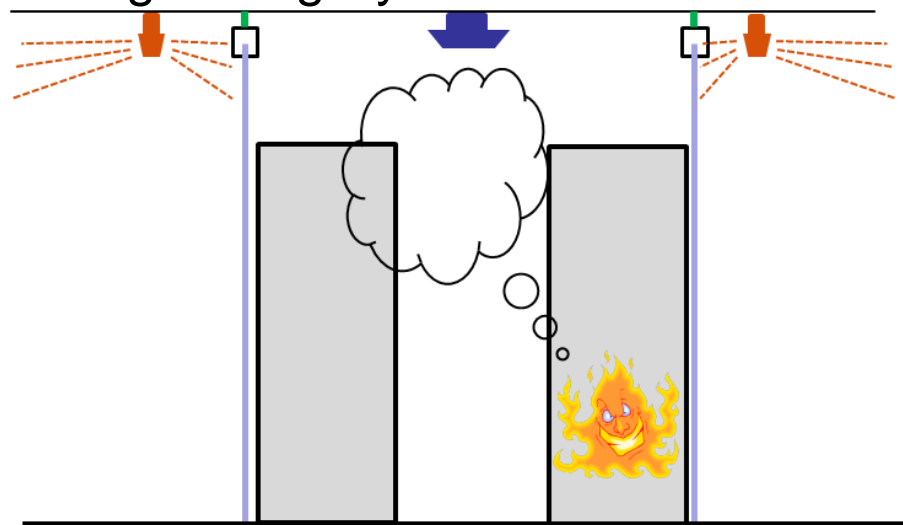


5 Fire Protection Challenges

Challenge # 2: Inadequate automatic obstruction removal

□ Does not address Clean Agent Extinguishing Systems

- ✓ Typically smoke not heat detection
- ✓ Operates long before elevated ceiling temperatures

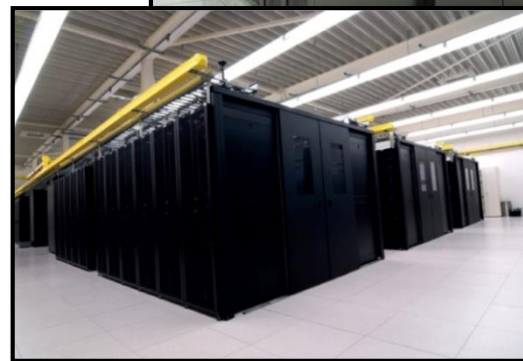


5 Fire Protection Challenges

Challenge # 3: Multiple areas of containment (separate volumes)

Impacts...

- ❑ Clean Agent concentration development
- ❑ Smoke Detection coverage and spacing
- ❑ Smoke Detection cross-zoning sequences



5 Fire Protection Challenges

Challenge # 3: Multiple areas of containment (separate volumes)

Will the Clean Agent concentration develop within each area of containment?



□ New NFPA 2001 requirement

- ✓ “Each volume...”
- ✓ Provide detectors, piping and nozzles

NFPA 2001 (2018 Edition)

5.3.5.2 Each volume, room, and raised or sunken floor to be protected shall be provided with detectors, piping network, and nozzles.

5 Fire Protection Challenges

Challenge # 3: Multiple areas of containment (separate volumes)

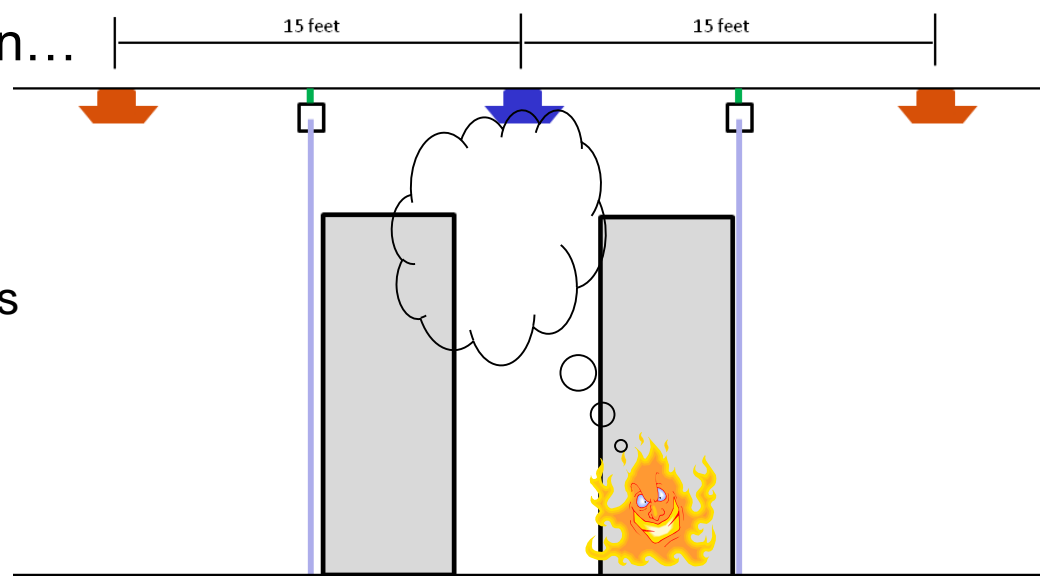
Cross-zone smoke detection...

- ❑ Conventional FACP

- ✓ 2 circuits (zones)
- ✓ May require 2 detector types

- ❑ Addressable FACP

- ✓ “Counting” Zone
- ✓ May require 2 detectors

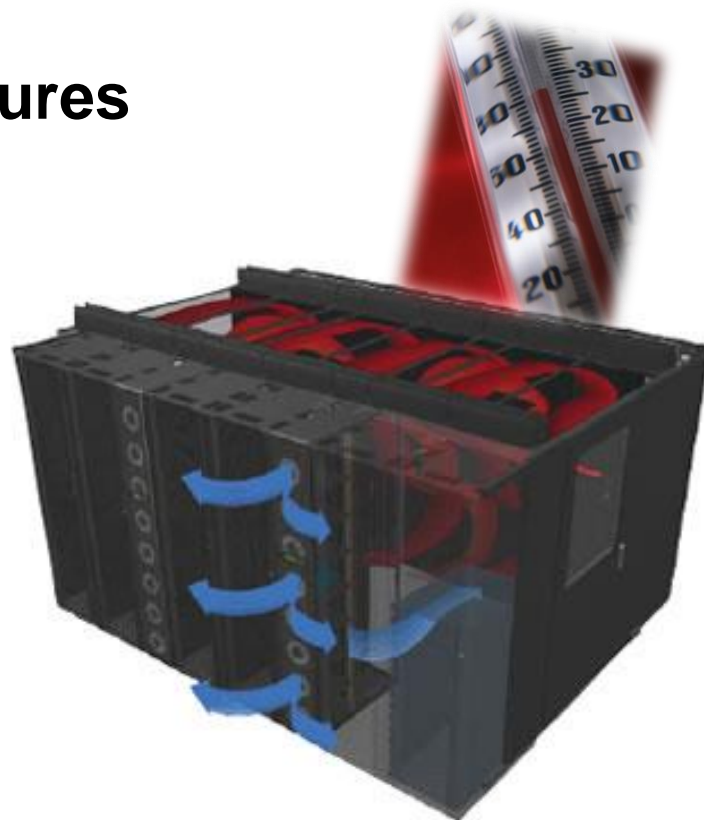


5 Fire Protection Challenges

Challenge # 4: High temperatures

Impacts...

- ❑ Sprinkler temperature rating
- ❑ Smoke detection operating temperature range
- ❑ Clean agent concentration adjustments

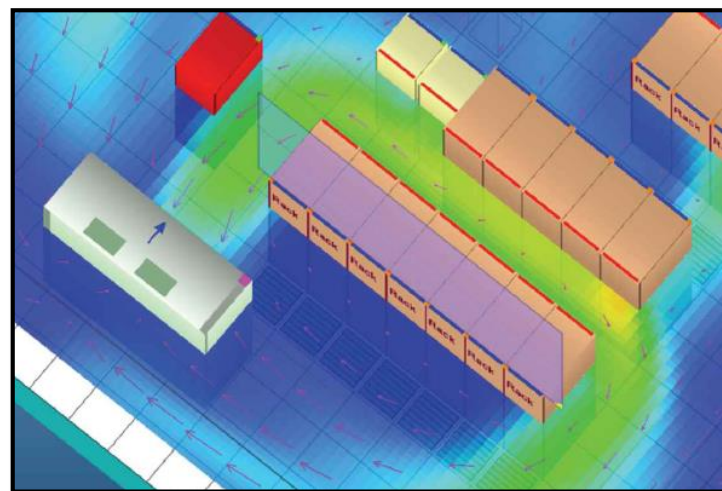


5 Fire Protection Challenges

Challenge # 5: High airflow velocities

Impacts...

- ❑ Smoke Detection performance
- ❑ Clean Agent dispersion



NFPA 75 – Addressed in 2013

- Standard for the Protection of Information Technology Equipment
 - 2013 edition effective July 29, 2012
- New Section 5.6 Aisle Containment and Hot Air Collar Systems for ITE
- Challenges addressed with 8 new requirements



3.3.15 ITE System. Any electronic digital or analog computer, along with all peripheral support, memory, programming, or other directly associated equipment, records, storage, and activities.

NFPA 75 – Requirement

① Constructed with Fire Retardant Materials

- Flame spread index < 50
- Smoke development < 450



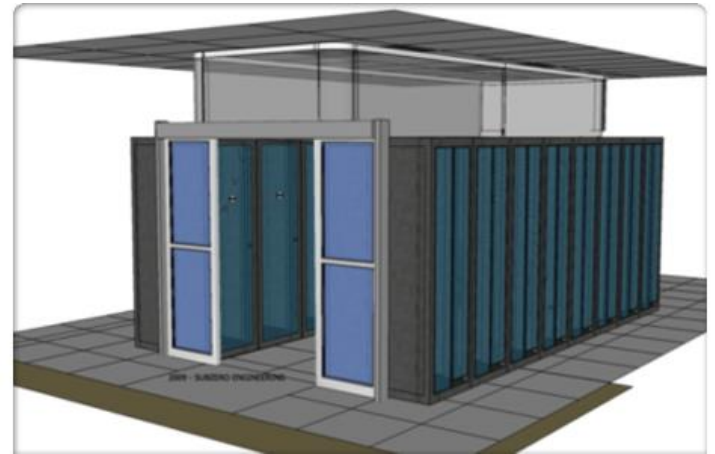
6.7.3 Elements of aisle containment and hot air collars shall be constructed of materials that have a maximum flame spread index of 50 and a maximum smoke development of 450 in accordance with one or more of the following:

- (1) ASTM E84, Standard Test Method for Surface Burning Characteristics of Building Materials;
- (2) UL 723, Standard for Test for Surface Burning Characteristics of Building Materials.

NFPA 75 – Requirement

② Not classified as plenum

- Aisle containment or hot air collars
- “Plenum-rated” construction materials are unnecessary



6.7.4* Aisle containment systems and hot air collars shall not be considered to be plenums.

NFPA 75 – Requirement

③ Rated for temperature max of hot aisles

- Hot Aisles:
 - ✓ Normal operation up to 120°F
 - ✓ HVAC failure possible 150°F
- Smoke Detection:
 - ✓ Typical max. operating temp. of 100°F or 120°F
- Heat Detection / Sprinklers:
 - ✓ Consider when selecting temp. rating



6.7.6* Detection and suppression components within aisle containment systems shall be rated for the intended temperatures of hot aisles when installed in those locations.

NFPA 75 – Requirement

④ Retrofitted Aisle Containment: Consider Existing Fire Systems

- Maintain compliance with applicable NFPA codes and standards
- Evaluate design
- Modify installation
- Reacceptance test



6.7.7 Where aisle containment systems are installed, the existing suppression and detection systems shall be evaluated, modified and tested as necessary to maintain compliance with the applicable codes and standards.

NFPA 75 – Requirement

⑤ Sprinkler Systems: Address Obstructions

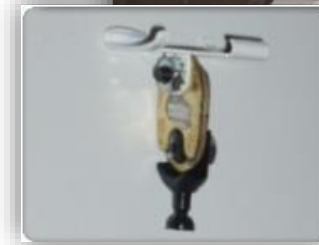
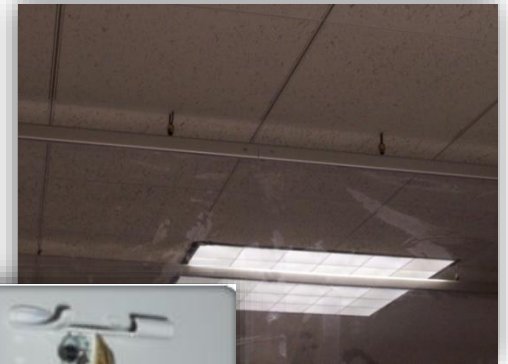
- Follow NFPA 13 requirements
- Modify sprinkler system as necessary



6.7.8 Where automatic sprinklers are present and the application of aisle containment systems or hot air collars creates obstructions to proper operation of sprinkler systems, the sprinkler system shall be modified as necessary to comply with NFPA 13.

NFPA 75 – Requirement

- ⑥ Sprinkler Systems: Automatic Obstruction Removal only if...
 - a. Removed by Smoke Detection
(Thermal Mechanical and Fusible Links not permitted)
 - b. Releasing devices are listed for the purpose
 - c. Remove all obstructions for entire suppression zone
 - d. Removal doesn't impact egress
(per NFPA 101)
 - e. Doesn't lower intended level of protection



6.7.8.1* Sprinkler system modifications shall not be required where all of the following conditions are met: ...

NFPA 75 – Requirement

⑦ Gaseous Suppression Systems: Address Aisle Containment

- Required concentrations throughout entire protected volume (per NFPA 2001)
- Modify suppression system as necessary

6.7.10 If the aisle containment prevents the gaseous suppression system, where present, from producing the required design concentrations throughout the entire volume served, the gaseous suppression system shall be modified to produce the required concentration throughout the volume served.



NFPA 75 – Requirement

⑧ Gaseous Suppression Systems: Automatic Obstruction Removal only if...

- a. Removed by Smoke Detection
(Thermal Mechanical and Fusible Links not permitted)
- b. Releasing devices are listed for the purpose
- c. Removed prior to agent discharge
- d. Remove all obstructions for entire suppression zone
- e. Removal doesn't impact egress
(per NFPA 101)
- f. Doesn't lower intended level of protection



6.7.10.1* Gaseous suppression system modifications shall not be required where all of the following conditions are met:...

New Research Planned

- In 2020 FSSA is partnering with the FIA to conduct testing on clean agent distribution
- Research will include
 - Agent dispersion during airflow conditions
 - Aisle containment without nozzles
 - An operating data center
- Will answer whether automatic obstruction removal is required for gaseous systems



Smoke Detection Performance

- Really High Airflow Rates
 - Possible 500 to 1,000 ACH
 - Dilutes smoke
 - High velocity air movement
- Need for better design guidance
 - NFPA 72 tables stop at 60 ACH
 - Fire Protection Research Foundation Project
 - “Develop modeling tools for reliable analysis of detection performance in high airflow conditions.”*

Minutes per Air Change	Air Changes per Hour	Spacing per Detector	
		ft ²	m ²
1	60	125	12
2	30	250	23
3	20	375	35
4	15	500	46
5	12	625	58
6	10	750	70
7	8.6	875	81
8	7.5	900	84
9	6.7	900	84
10	6	900	84

Table 17.7.6.3.3.1 Smoke Detector Spacing Based on Air Movement

NFPA 72 (2019) – Annex B

B4.5 . . . There are currently no quantitative methods for estimating either smoke dilution or airflow effects on locating smoke detectors. . .

Current NFPA 75 Requirements



Provide Early Warning Fire Detection

- Smoke detection is required
 - At ceiling level throughout information technology equipment area
 - Below raised floors containing cables
 - In exhaust/return air stream where aisle containment systems are used
 - In the return air stream where the above ceiling area is used as a return air plenum
 - To operate required smoke dampers - Above suspended ceilings and raised floors (If used to circulate air to other parts of the building or where suppression systems may be deployed)

Smoke Detection Solutions

- Air Sampling detection systems are a leading solution

Hot Aisle Containment

- Detection Location

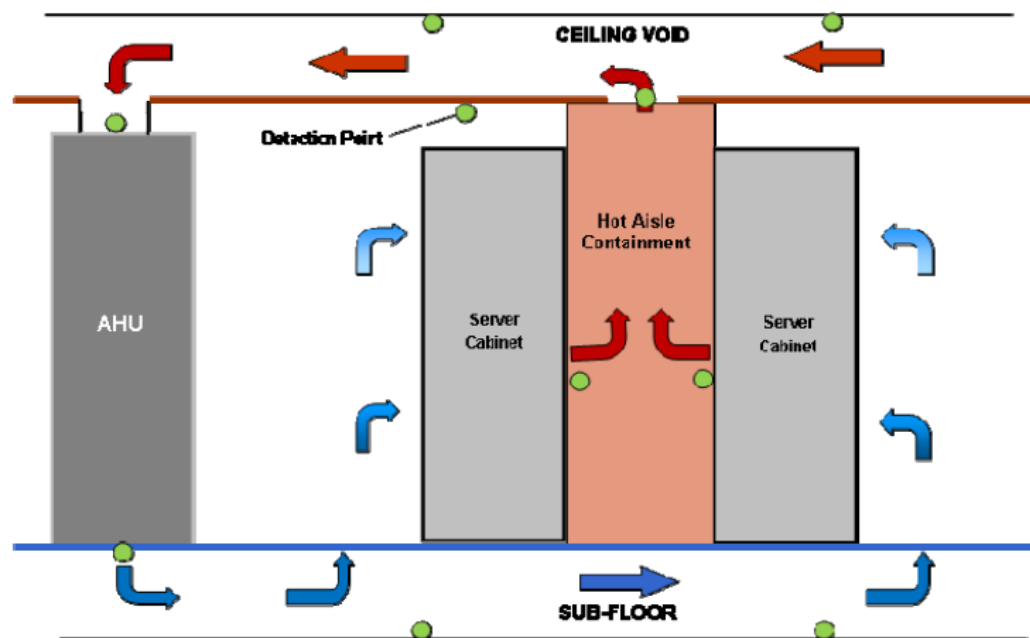


Image: Xtralis Whitepaper – Telecommunications and Data Processing Facilities Design Guide

Smoke Detection Solutions

- Air Sampling detection systems are a leading solution

Cold Aisle Containment

- Detection Location

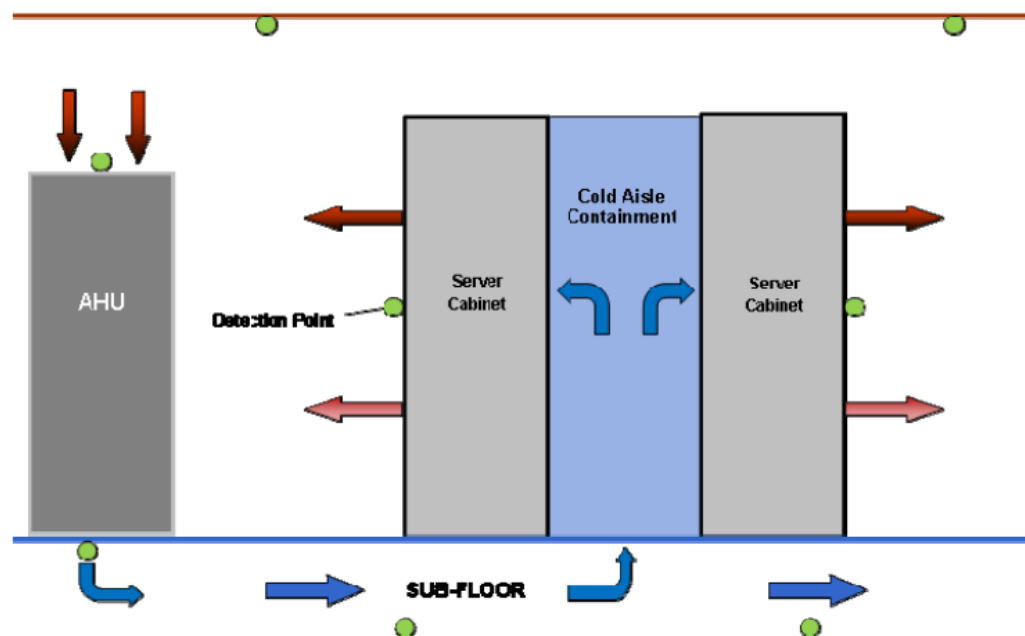


Image: Xtralis Whitepaper – Telecommunications and Data Processing Facilities Design Guide

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Fire Protection for Hot and Cold Aisle Containment
Systems in Data Centers



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