

Planned Updates to FM Approval Standard Class 5560, Water Mist Systems, for 2015 Revision

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- Addition of Physical Scaling for Total Flooding Compartment Applications
- New Fire Test Appendices for the Protection of Data Processing Equipment Rooms/Halls
 - Protection of Above-Raised Floor Space
 - Protection of Below-Raised Floor Space

Why scale water mist fire suppression?

- To reduce the development cost of water mist fire protection systems.
 - Currently, full-scale testing is required for system development and listing.
 - Full-scale fire testing costs are often prohibitive for niche applications.
- Goal: replicate water mist fire protection with scaled-down facilities.

- FM Global conducting research work with the intent to reduce testing from large scale to intermediate scale for total flooding water mist applications. The research includes:

- Nozzle water droplet characterization (drop size distribution, droplet momentum, spray angle/pattern, etc.)
- Scaling methodology to scale down the large scale fire tests. The scale could be 1/2 or 1/3 of previous large scale fire tests.

- Froude-based scaling laws have been validated with a series of laboratory experiments for the effects of droplet size, fire radiation, enclosure and different types of combustibles by FM Global Research.
- Using these scaling laws the protection of an ignitable liquid cut-off room has been successfully developed by scaling up the known protection requirements for a smaller enclosure.

To do: Demonstrate that the fire protection performance of an existing water mist system listed per FM Approval Standard for the protection of 260 m³ machinery enclosure can be reasonably replicated in a ½-scale enclosure.

- Plan:
- 1) Measure the Approved system's water mist spray.
 - 2) Develop the ½-scale spray based on the full-scale spray.
 - 3) Calibrate the scaled-down fires per the scaling requirement.
 - 4) Construct the ½-scale machinery space enclosure per the full-scale enclosure specifications given in FM Approval Standard 5560, Appendix C.
 - 5) Conduct ½-scale tests for the fire scenarios prescribed in Appendix C.
 - 6) Implement the scaling approach to FM Approval Standard 5560 for the enclosure protection.

- New appendix in FM Approval Standard 5560 for scaling approach:
 - Manufacturer applies for FM Approval with parameters for full-scale protection.
 - Manufacturer submits full-scale nozzle and scaled-down nozzle for spray measurements to ensure they meet the scaling requirements.
 - Fire testing conducted with scaled-down nozzles in scaled down enclosure.
 - Approval granted for full-scale protection by scaling up the scaled-down test results according to the scaling relationships.

- Initial reduction in cost
- Initial reduction in FM Approvals cycle
- Potential reduction in time to manufacturer could be significant in the development phase due to the screening test availability.
- Potential reduction in required number of reduced scale tests in the future (after gaining some experience)
- Ultimately increase the number of certified applications!

Physical Scaling - Summary



- The Froude-based scaling laws have been validated with laboratory experiments for the effects of droplet size, fire radiation, enclosure and different types of combustibles by FM Global Research.
- The protection of an ignitable liquid cut-off room has been successfully developed by scaling up the known protection requirements for a smaller enclosure.
- Further validation work is ongoing using a currently FM Approved water mist systems for the protection of machinery in enclosures.

- New Fire Test Appendices for the Protection of Data Processing Equipment Rooms/Halls
 - Protection of Above-Raised Floor Space
 - Protection of Below-Raised Floor Space

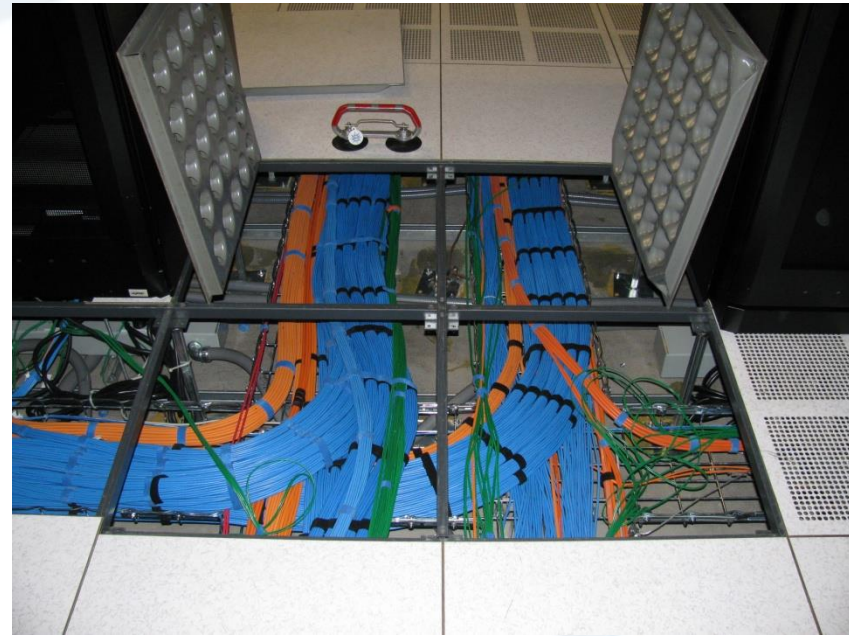
Combustible Loading

- Cables / Cable trays
- Combustibles



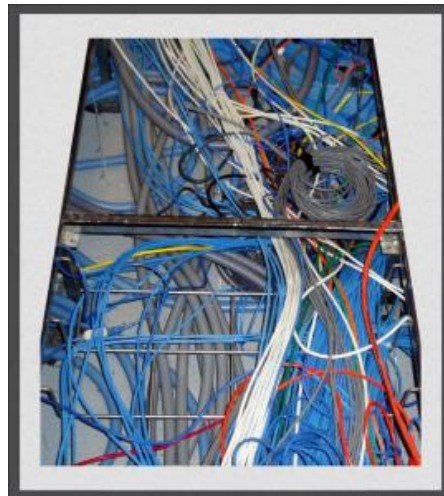
Cables / Cable Trays

- Location
 - Above floor
 - Below floor



Cables / Cable Trays

- Combustibility
 - Non-rated
 - UL Plenum rated / FM Approved - cables
 - FM Approvals 4910 plastics / UL plenum-rated - trays



General Combustibles

- FM Global Datasheet 5-32, Data Centers and Related Facilities, recommends limiting the amount of new equipment with packaging awaiting installation to two pallet loads on the floor (not stacked).

Challenges to Fire Protection Systems



Sprinkler System

- Everything gets wet



Water Mist System

- Performance not proven



Clean Agent System

- Size, size, size

Challenges to Fire Protection Systems

- Ceiling height
 - response time increases
 - momentum of discharge to penetrate fire plume
 - Sprinklers- ceiling limit to ~ 9 m (30 ft)
 - Water mist – ceiling limit to ~ 5 m (16 ft)
 - Clean Agent – ceiling limit to ~ 4.3 to 5.5 m (14 to 18 ft)

Challenges to Fire Protection Systems

- Classification of hazard
 - Above-Floor - Light or Ordinary Hazard (propagating cables)
 - Below-Floor
 - Plenum rated cable - only smoke detection
 - Propagating cable - protection required

Challenges to Fire Protection Systems

- Obstructions
 - Cable trays
 - Optical fiber cable raceways
 - Ventilation ducts
 - Hot/Cold aisle containment
 - Ceilings
 - Containment curtains



Challenges to Fire Protection Systems

- Impact of Ventilation
 - Airflow around thermal element potentially delaying operation
 - Loss of Cooling - powering down to terminate ventilation can cause further issues due to overheating equipment

Water Mist Systems

- Current state of FM Global Datasheet 5-32 Recommendations
 - Use FM Approved system for the protection of Non-Storage Occupancies, Hazard Category 1 (HC-1) [formerly Light Hazard Occupancies]
 - No propagating cables allowed in room
 - Automatic interlock to shutdown ventilation required
 - Pre-Action systems not permitted

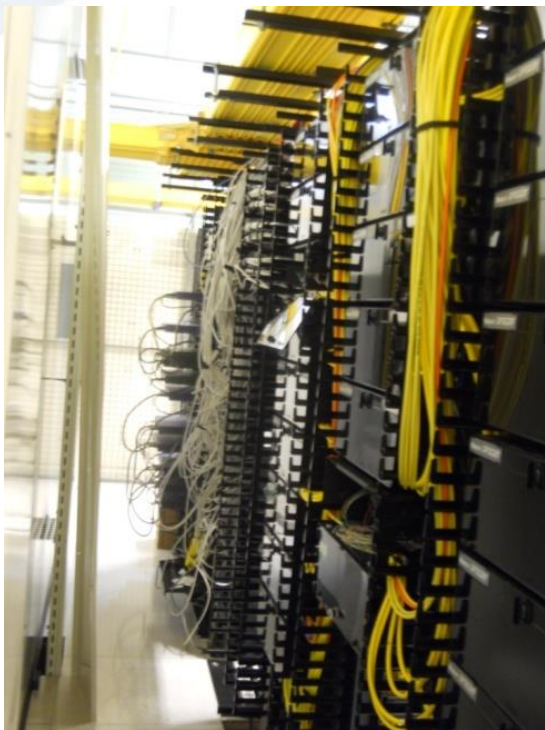
Challenges for Water Mist Systems

- Currently not evaluated for the following:
 - Propagating cable
 - Active forced ventilation
 - Water delivery delay (pre-action)



Objectives

- Evaluate the specific fire load for a data processing equipment room/hall



Cables

Objectives

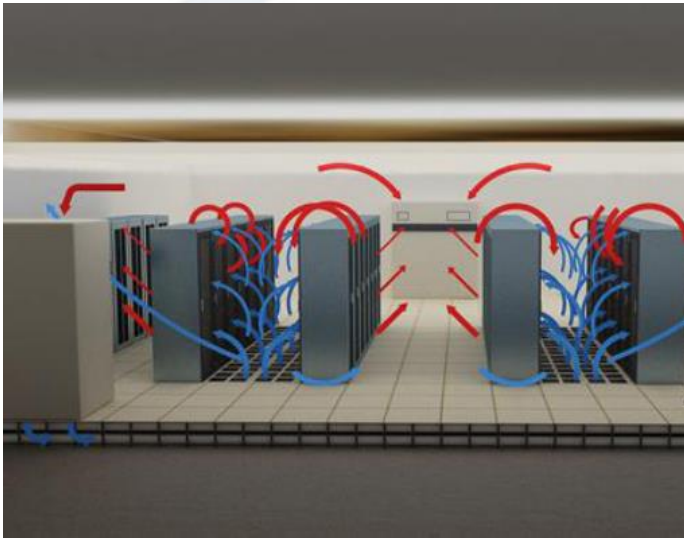
- Evaluate the specific fire load for a data processing equipment room/hall

Cartoned products with
foam packaging



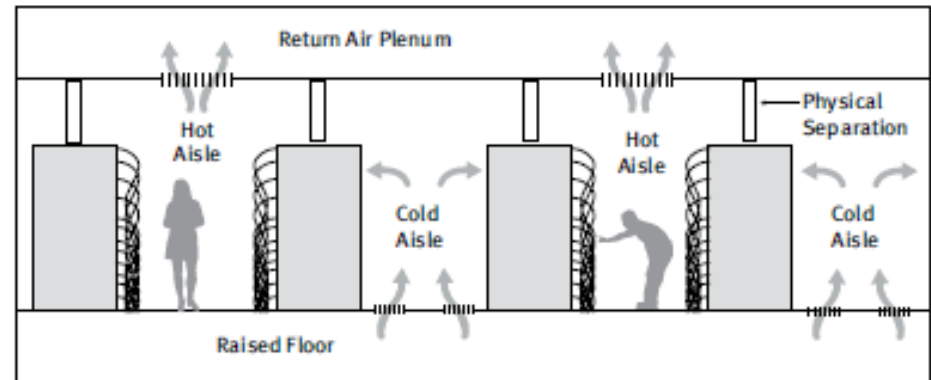
Objectives

- Evaluate forced ventilation



- Without containment

- With containment



Objectives

- Evaluate water delivery time delay
 - Single vs Double Interlock systems
 - Rely on:
 - Fire detection system
 - Preaction valve and interlock

Planned Protocol – Above-Floor

- **Simulate unrestricted area/enclosure for open server configuration:**
 - Cold aisle and hot aisle air flow
 - Vertical airflow velocity approx 1 m/sec (3 ft/sec) from raised floor
 - Horizontal airflow velocity from server unit fans approx 1.2 m/sec (4 ft/sec)
 - Exhaust fans located in simulated server cabinets
- **System water delivery options for testing:**
 - Wet
 - 30 second delay
- **Nozzle parameters for testing:**
 - maximum spacing
 - maximum ceiling height
 - maximum distance from ceiling
 - minimum nozzle pressure

Planned Protocol – Above-Floor

- **Two fire scenarios planned**
 - Cable Scenario
 - Overhead Cables
 - Vertical cable bundle to horizontal cables in metal tray – propagating type
 - Secondary cable trays and servers to act as obstruction
 - Carton Scenario / Cartoned Material
 - Cartons with polystyrene foam inside
 - Intended to replicate to pallet loads (not stacked) allowed in 5-32

- **Evaluation Criteria**
 - Ceiling perimeter temperatures measured to determine potential operating area of protection
 - Steel angle below ceiling not to exceed 538°C (1000°F)
 - CABLES - Fire not spread to end of cable tray, or
 - CARTONS - Fire not to spread to far end of carton stack.

Planned Protocol – Below-Floor

- **Simulate unrestricted area/enclosure:**
 - 4 different cable tray scenarios
 - Single-tier tray and optional double-tier tray
 - Tray located between perforated floor tiles and under perforated floor tiles.
 - Vertical airflow velocity approx 1 m/sec (3 ft/sec) from raised floor.
- **Nozzle parameters for testing:**
 - maximum spacing
 - maximum distance from ceiling
 - minimum nozzle pressure
- **Evaluation Criteria:**
 - Fire not to spread to opposite end of cable tray
 - Gas temperature below ceiling not to exceed 538°C (1000°F)

Summary

- The hazards and challenges for fire protection systems in data centers have been identified.
- The current state of FM Global recommendations for the use of water mist systems in data centers has been considered with these hazards and challenges in mind.
- New fire test protocols have been planned to enable testing of water mist systems for data centers without the restrictions currently in place. Work is ongoing.

Questions?

