

# **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 m<sup>3</sup> 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

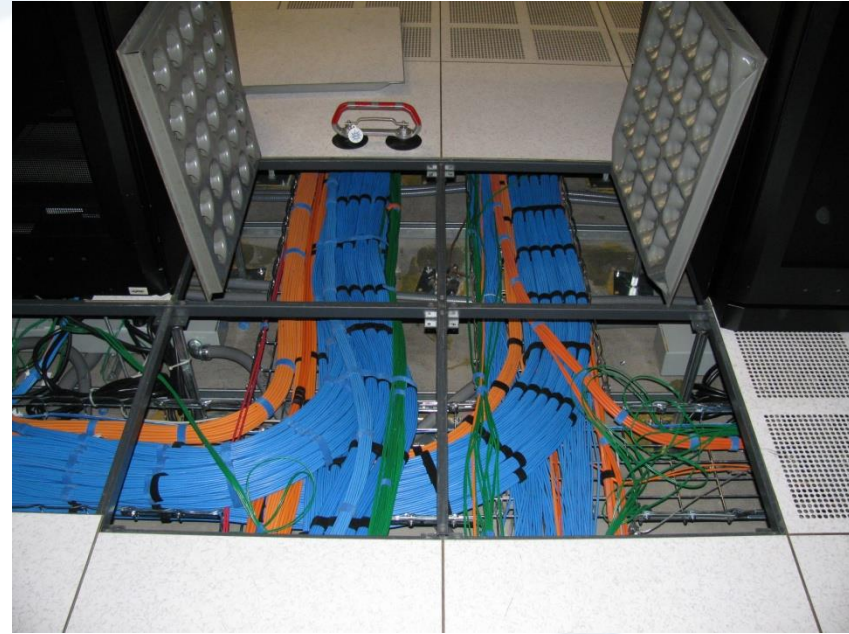
## Combustible Loading

- Cables / Cable trays
- Combustibles



## Cables / Cable Trays

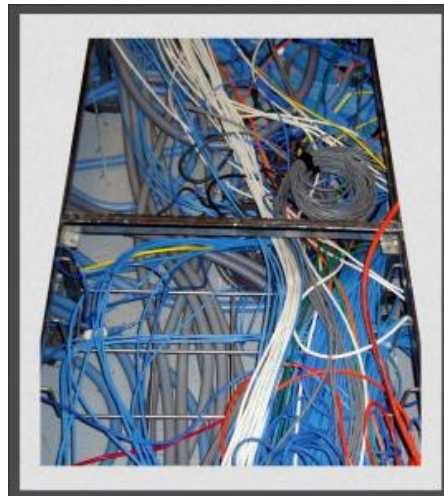
- Location
  - Above floor
  - Below floor





## 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

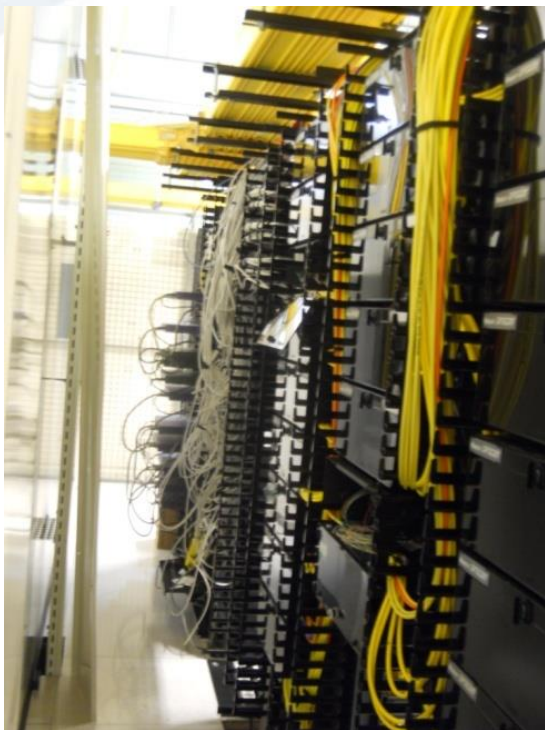
## Challenges for Water Mist Systems

- 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

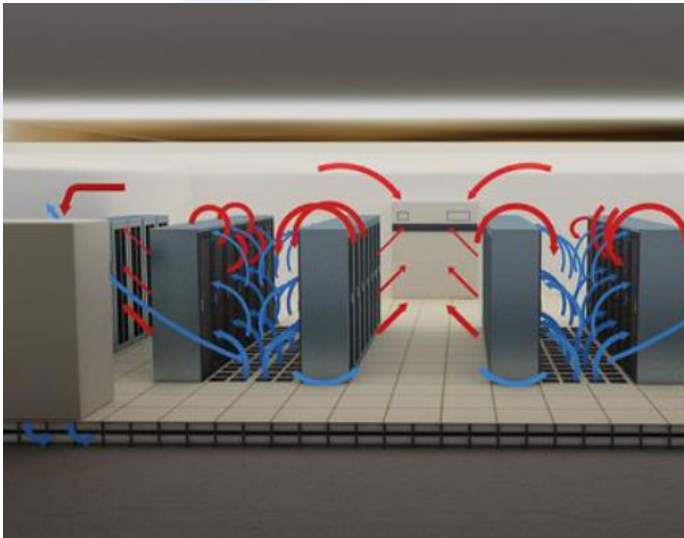
- Evaluate the specific fire load for a data processing equipment room/hall

Cartoned products with  
foam packaging



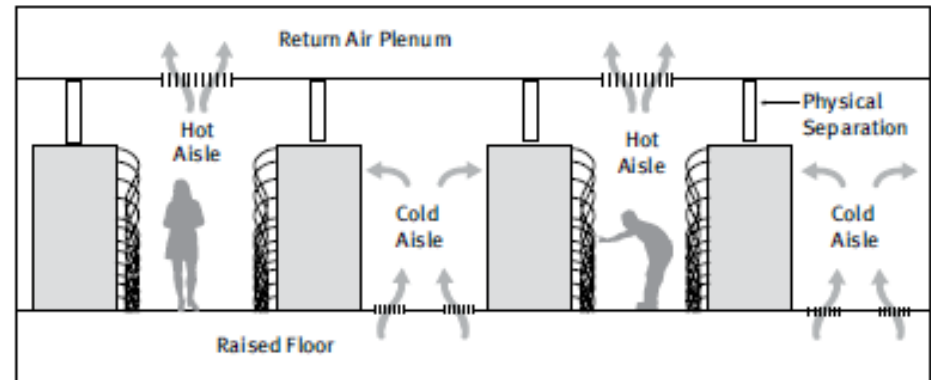
## Objectives

- Evaluate forced ventilation



- With containment

- Without 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?

