Water Mist Fire Suppression

Lorraine Smith (Vertical Sales Manager)

Systems
Hardware

HI-FOG® water mist fire protection

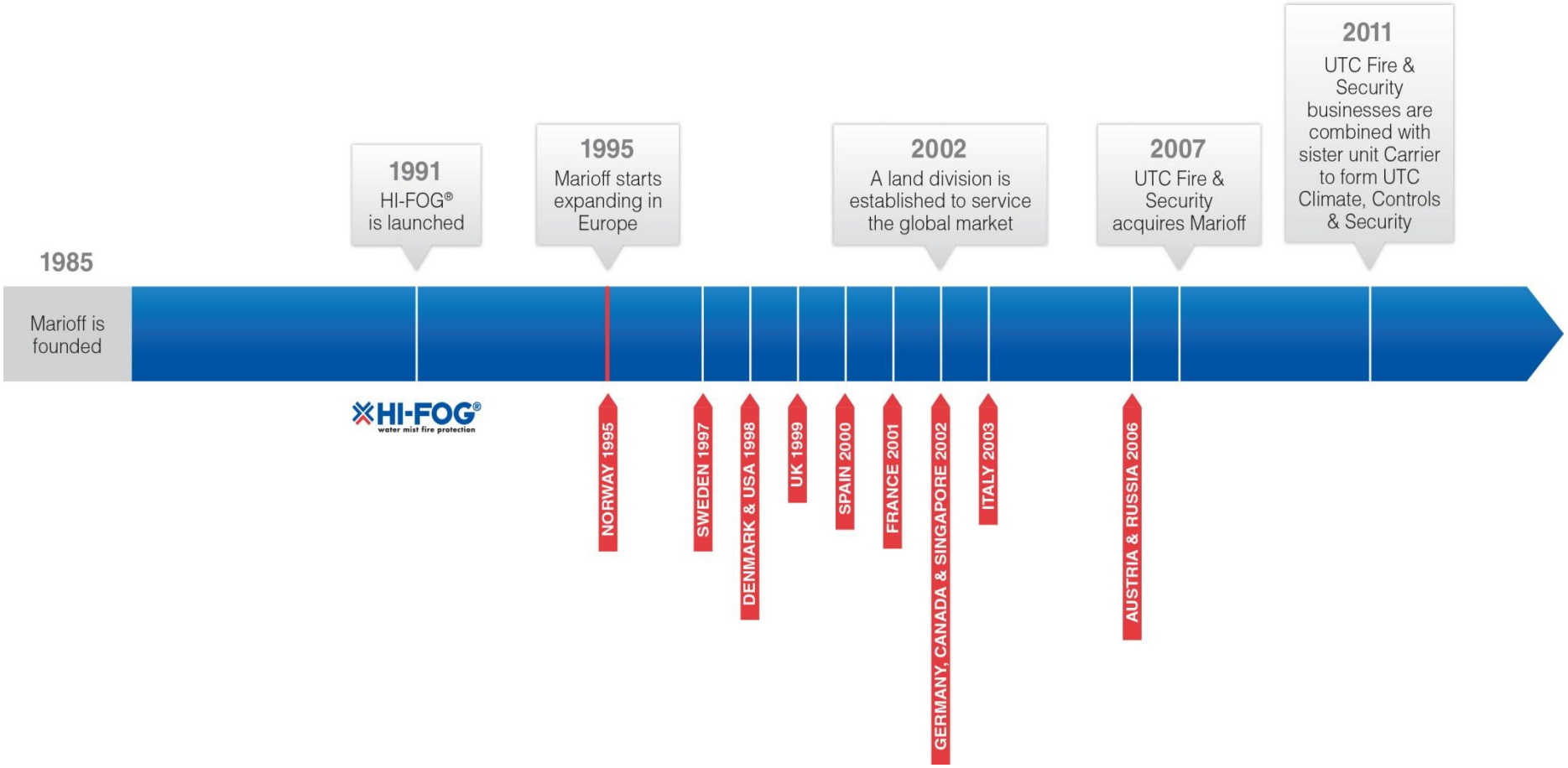
PART 1 - The Marioff Group

Activity	Fire protection system manufacturer and supplier
Product	HI-FOG® Water Mist Fire Protection System
Mission	Protecting people, property & business continuity from fire
Core benefits	Reduced fire, smoke and water damage

- Minimal business interruption
- Environmentally friendly

MARIOFF United Technologies

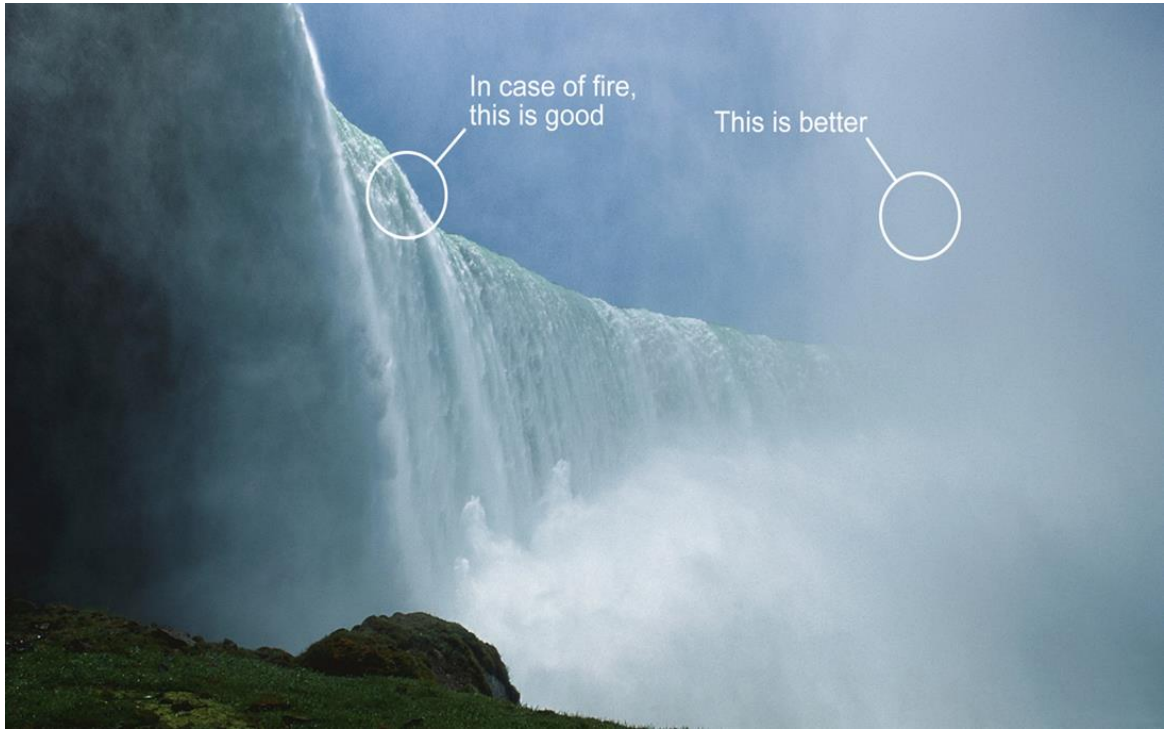
Marioff history



Agenda

- What is water mist
- Codes & Standards
- How mist fights fire
- Applications
- Design Principles
- Fire test
- Questions

What is water mist?



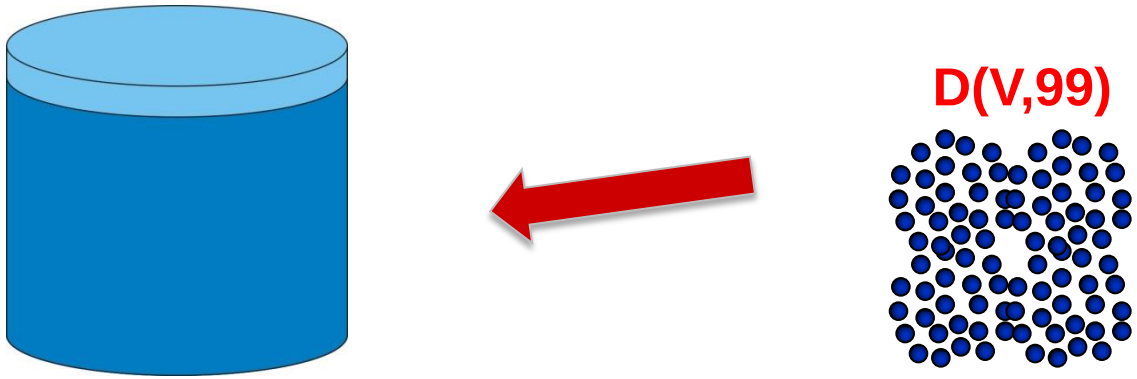
Water Mist Definition – NFPA 750

Water Mist:

A water spray for which the $Dv_{0.99}$, for the flow weighted cumulative volumetric distribution of water droplets, is less than 1000 micron (1mm) within the nozzle operating pressure range.

- NFPA 750, 2015 Section 3.3.2

Volume Mean Diameter D(V,99) = 99% of water volume is in drops with diameter smaller or equal to this value



Water Mist Pressure

Pressure (classified by NFPA 750)

- Low Pressure < 12.1 bar (175 psi)
- Intermediate Pressure between 12.1 – 34.5 bar
- High Pressure > 34.5 bar (500 psi)

Water Droplet Size Comparison

Typical drop size range (mm)	Number of droplets per litre of water	Surface area (m^2)
1…5	15 thousand to 2 million	1…6
0.2…1	2 million to 250 million	6…30
0.025…0.2	**250 million to 150 billion** Superior cooling and local inerting	**30…250** Superior blocking of radiant heat

Water Mist Definitions – NFPA 750

3 different types of system applications

Local Application

- Designed to protect an object or hazard in an enclosed, unenclosed or open outdoor condition

Total Compartment

- Designed to provide complete protection of an enclosure or space

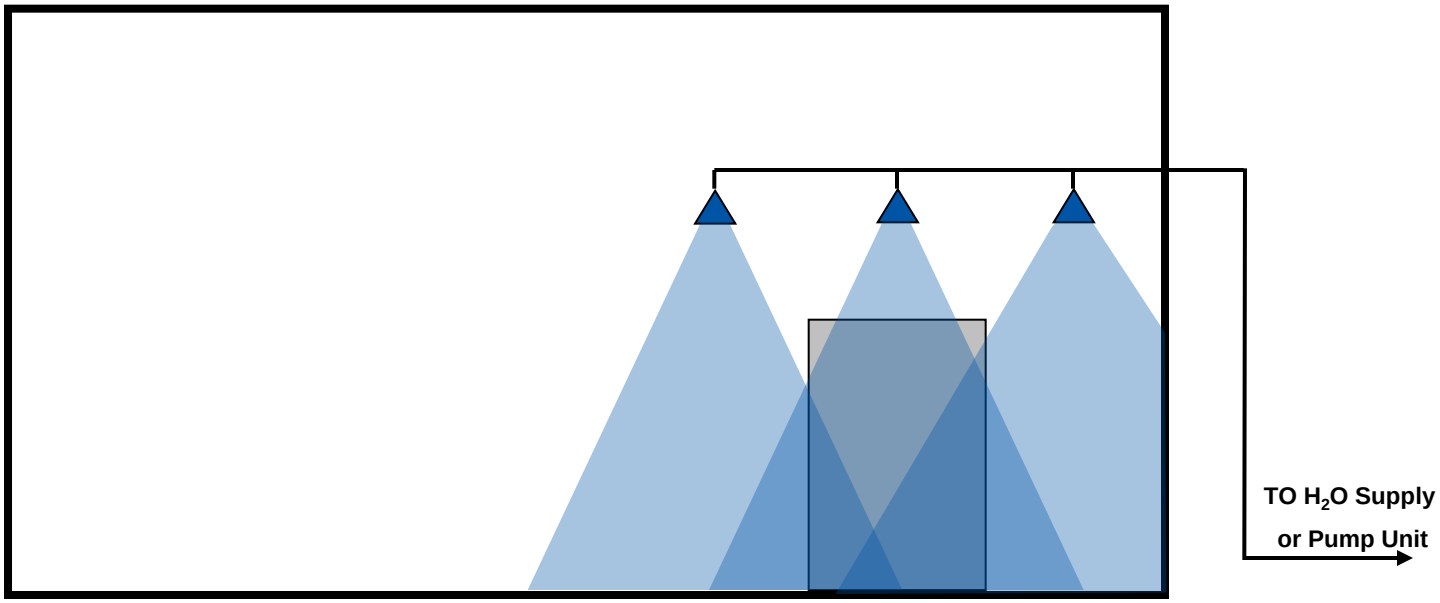
Zoned Application

- Designed to protect a predetermined portion of the compartment by the activation of a selected group of nozzles

Application Types

Local Application:

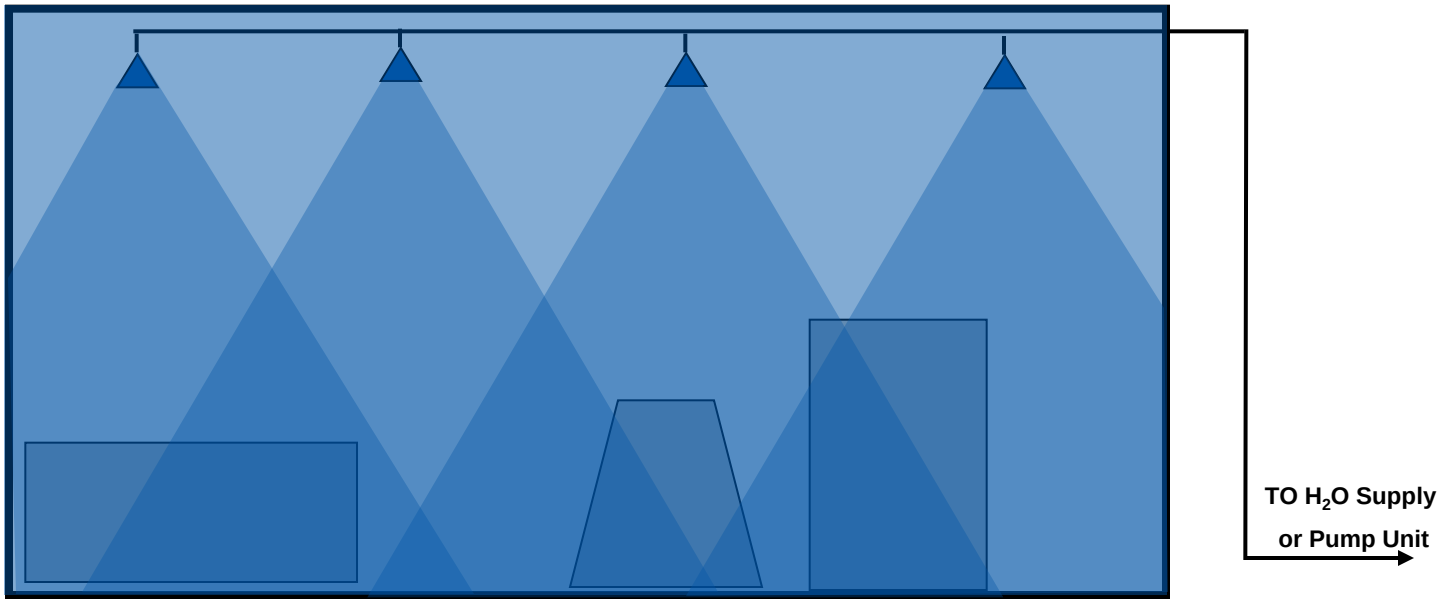
This configuration is used to protect a specific hazard or object. An example may be the protection of a piece of equipment in a large room or compartment. The system would be designed to discharge water mist directly onto the object



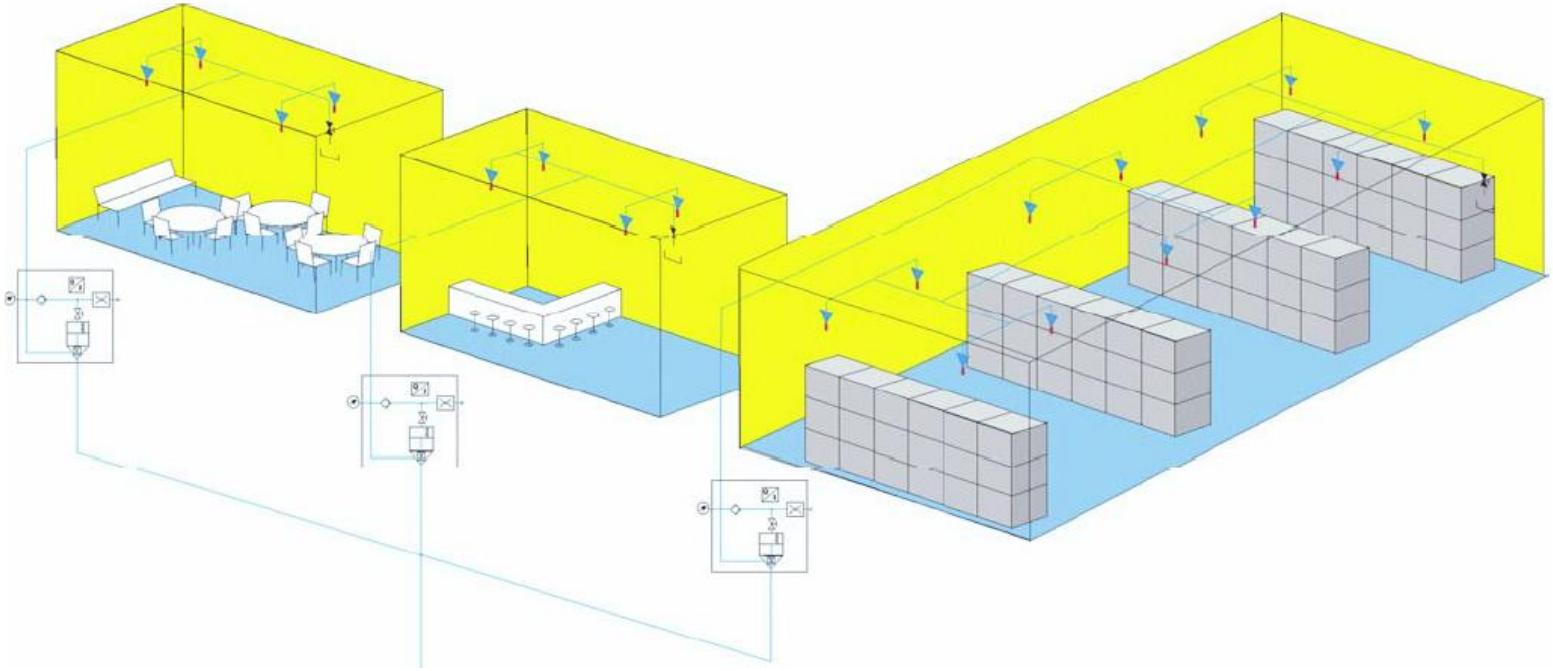
Application Types

Total Compartment Application:

Provides protection to all fire hazards and all areas in a compartment. The open nozzles are positioned in a grid so that water mist discharges approximately uniformly throughout the entire volume



Building Configuration



Water Mist Definitions – NFPA 750

Single Fluid System:

A water mist system utilizing a single piping system to supply each nozzle

NFPA 750, section 3.3.18

Twin-Fluid System:

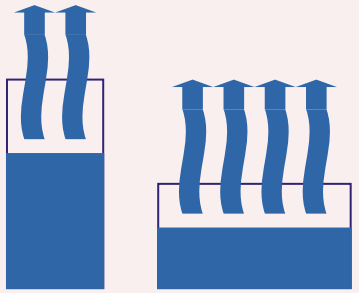
A water mist system in which water and atomizing medium are supplied to the water mist nozzle utilizing a separate piping system for each medium or a single piping system for both.

NFPA 750, section 3.3.20

EXTINGUISHINGING MECHANISMS OF WATER

EVAPORATION

When turning into vapor
water absorbs more heat than any other extinguishing agent
→ efficient cooling
the vapor (= inert gas) with >1700 exp
volume displaces oxygen
→ efficient inerting



Gases

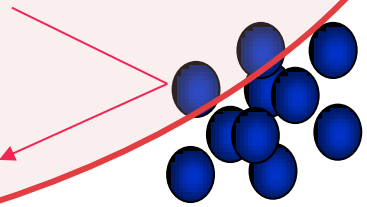
Traditional sprinklers

WETTING

Liquid water wets the surfaces and prevents fire spread

RADIANT HEAT ABSORBTION

small droplets absorb and scatter heat



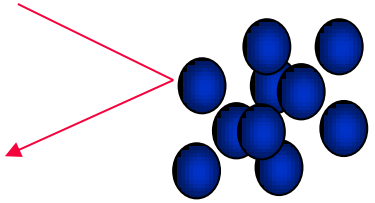
Water mist

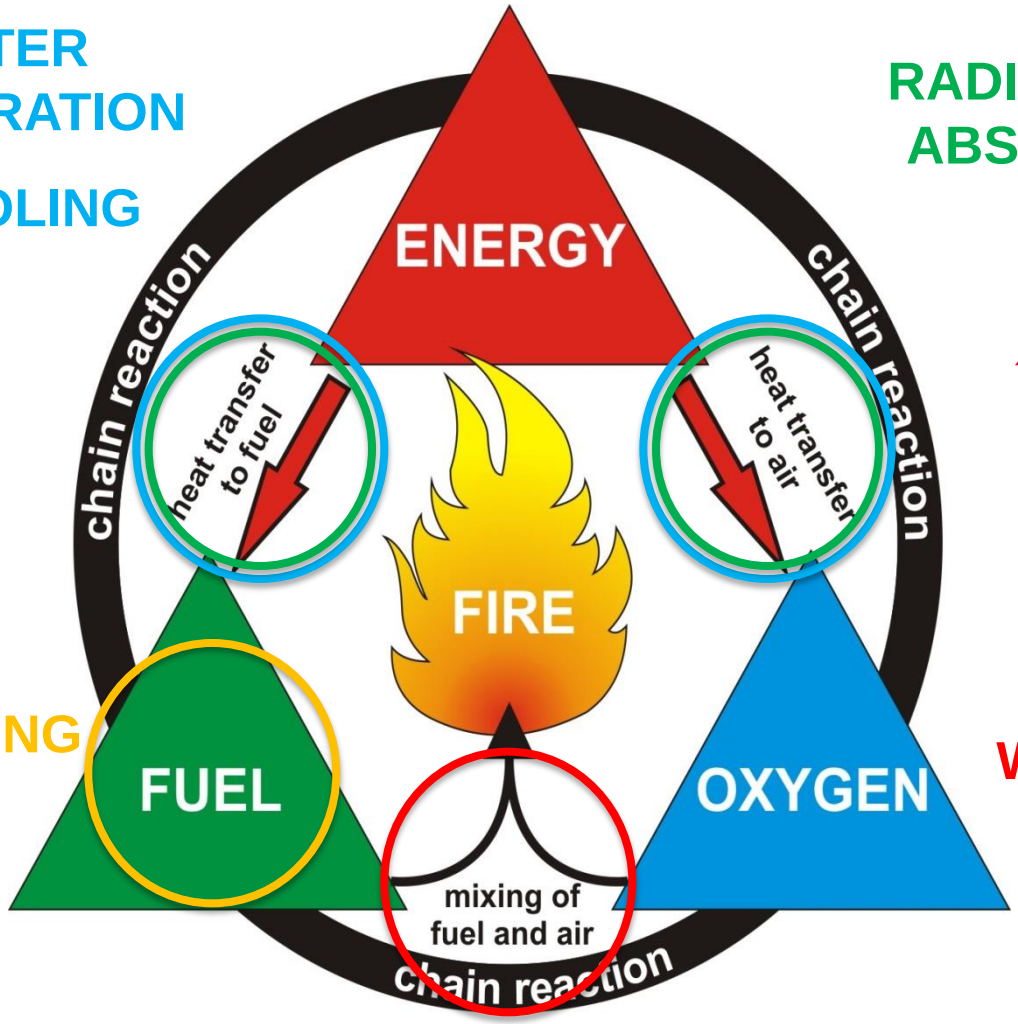
EXTINGUISHINGING MECHANISMS OF WATER

WATER EVAPORATION

= COOLING

RADIANT HEAT ABSORBTION





WETTING

WATER VAPOR

= INERTING

Applicable Standards Summary (Land)

	Design & installation guideline	Fire test Protocols	Component test protocols	Approvals
NFPA 750	☑ ☑	☑	☑	☑
FM 5560		☑	☑	☑
UL 2167				

Others:

CEN/TS 14972, VdS/CEA, VNIIPO/GOST, AS4587, IS15519, etc…

NFPA 750

Standard on Water Mist Fire Protection Systems

To be NFPA 750 compliant, a water mist system must meet the definition of water mist **AND** pass relevant fire test protocols

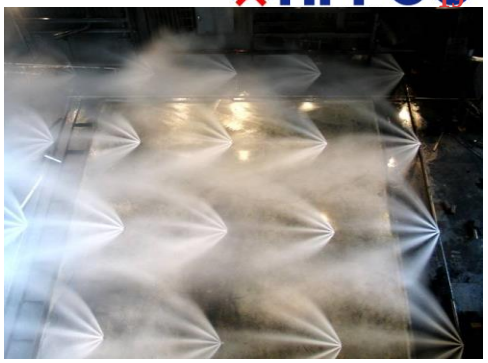
- **1.1* Scope.** This standard contains the minimum requirements for the design, installation, maintenance, and testing of water mist fire protection systems. This standard does not provide definitive fire performance criteria, nor does it offer specific guidance on how to design a system to control, suppress, or extinguish a fire. Reliance is placed on the procurement and installation of listed water mist equipment or systems that have demonstrated performance in fire tests as part of a listing process.

FM Approval Standard Water Mist Systems Class 5560

The standard includes:

- Definitions
- General guidelines for the approval process
- General demands from water-mist systems
- Fire-test protocols for variety of applications
- Components tests protocols
- Requirements from the quality control program
- References to other publications

Fire Fighting Concept



Performance of the system is NOT based on

- **pressure alone**
- **droplet size alone**
- **etc…**

Performance is evaluated in

FULL SCALE FIRE TESTS

WATER MIST IS NOT A GENERIC EXTINGUISHING AGENT !

Water Mist A ≠ Water Mist B

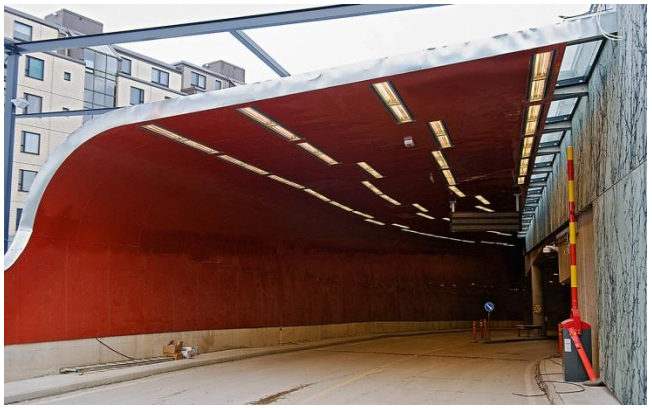
PERFORMANCE-BASED APPROACH

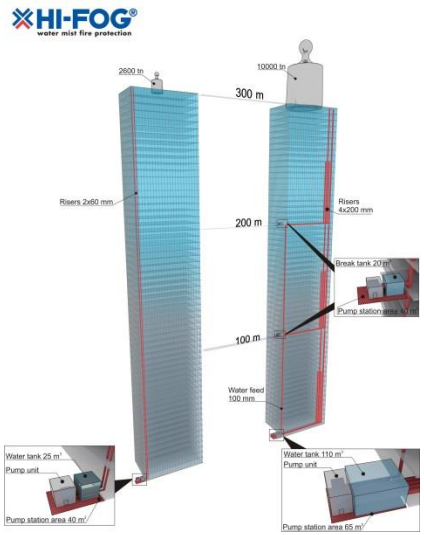
ALL critical water mist system dimensioning and installation parameters are defined in full-scale fire tests

Nozzle type

- **Operating pressure**
- **Spacing**
- **Water flow rate**
- **Max Installation height**
- **Max Protected volume**

Applications





Applications: Machinery Space

Content (FM 5560):

- oil pumps
- oil tanks
- fuel filters
- generators
- transformer vaults
- gear boxes
- drive shafts
- lubrication skids
- diesel engine driven generators
- other similar machinery using fuel and/or lubrication fluids with volatilities less than or equal to light diesel

Applications: Turbine Enclosure

Content (FM 5560):

- Turbines (the standard does not differentiate gas turbines from other turbines)

Applications: Special Hazard Machine Space

Content (FM 5560):

- Internal combustion engines, other equipment using fuel and/or lubrication fluids with volatilities less than or equal to Heptane.

HC-1 (Light Hazard) Applications

FM HC-1 (Light Hazard) approved water mist system can be used to protect the following, as per FM data sheet 4-2

- Residential occupancies
- Offices
- Meeting rooms
- Data processing centers
- And other similar spaces with respect to fire hazard, as determined by FM Global
- Institutions
- Schools
- Hospitals
- Churches
- Restaurant seating areas
- Hotels
- Museums (exhibit areas)

Note: All spaces in the above mentioned facilities are not necessarily HC-1 (Light Hazard) categorized occupancies

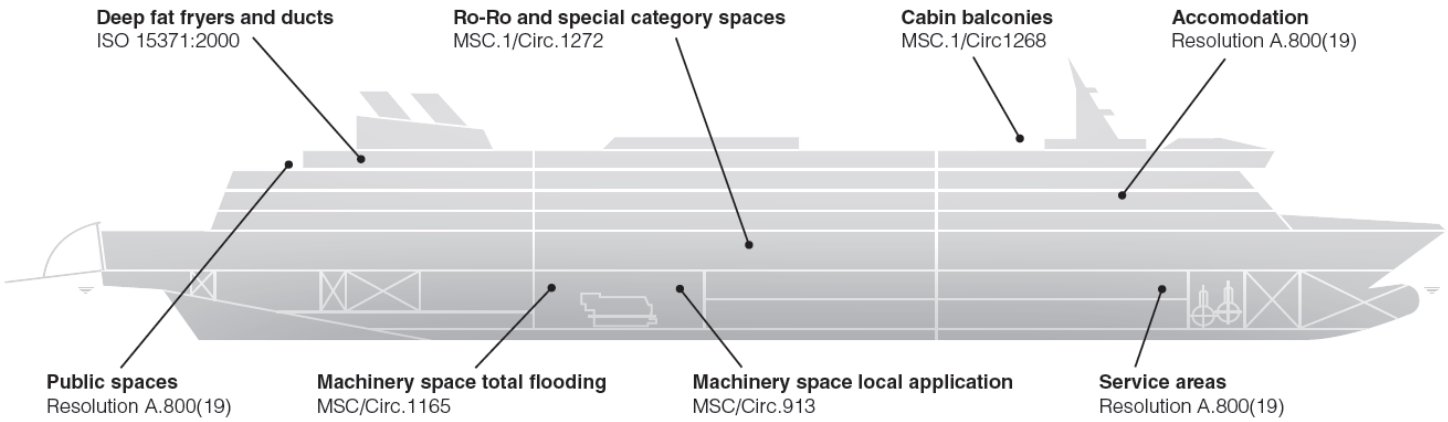
Applications – Commercial Buildings

- Archival/record storage
  - Cultural heritage
  - Medical
  - Data backup
- Museum
  - Galleries
  - Infrastructure
  - Storage
  - Common areas

- **Electronic equipment**
  - **Server farms**
  - **Colocation facilities**
  - **Data centers**
  - **Computer rooms**

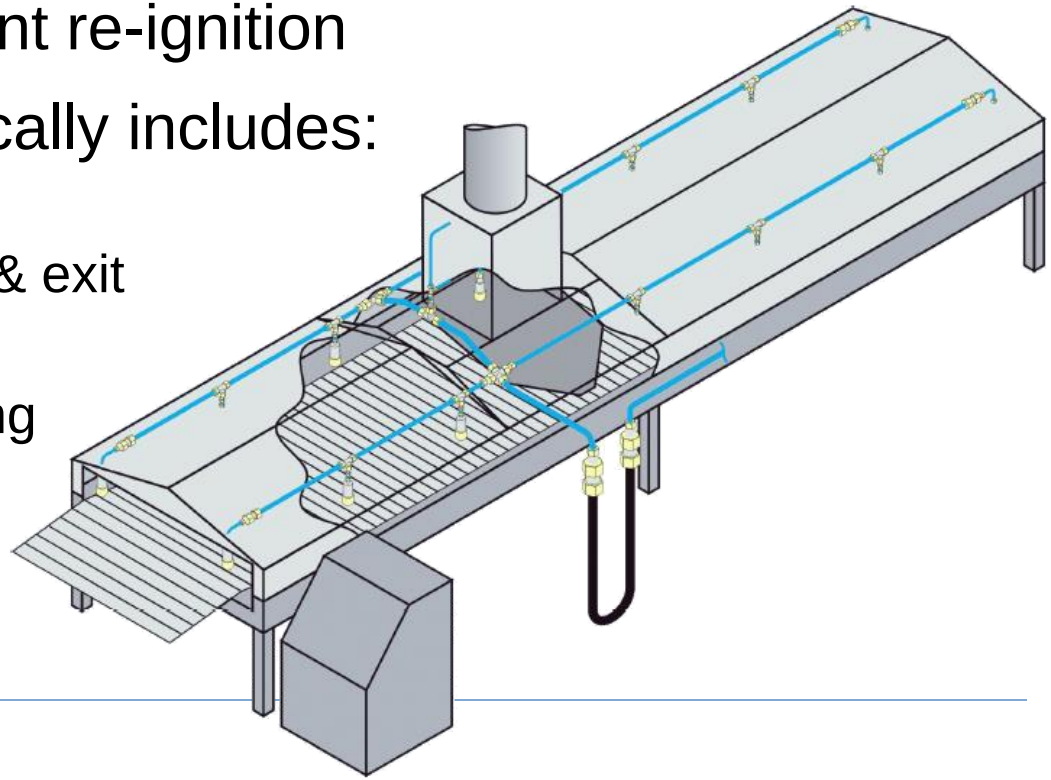
Applications – Marine

- PO&G
- Offshore / platforms
- Mega-yachts
- Cruise ships
- Protecting all elements of the marine vessel / facility

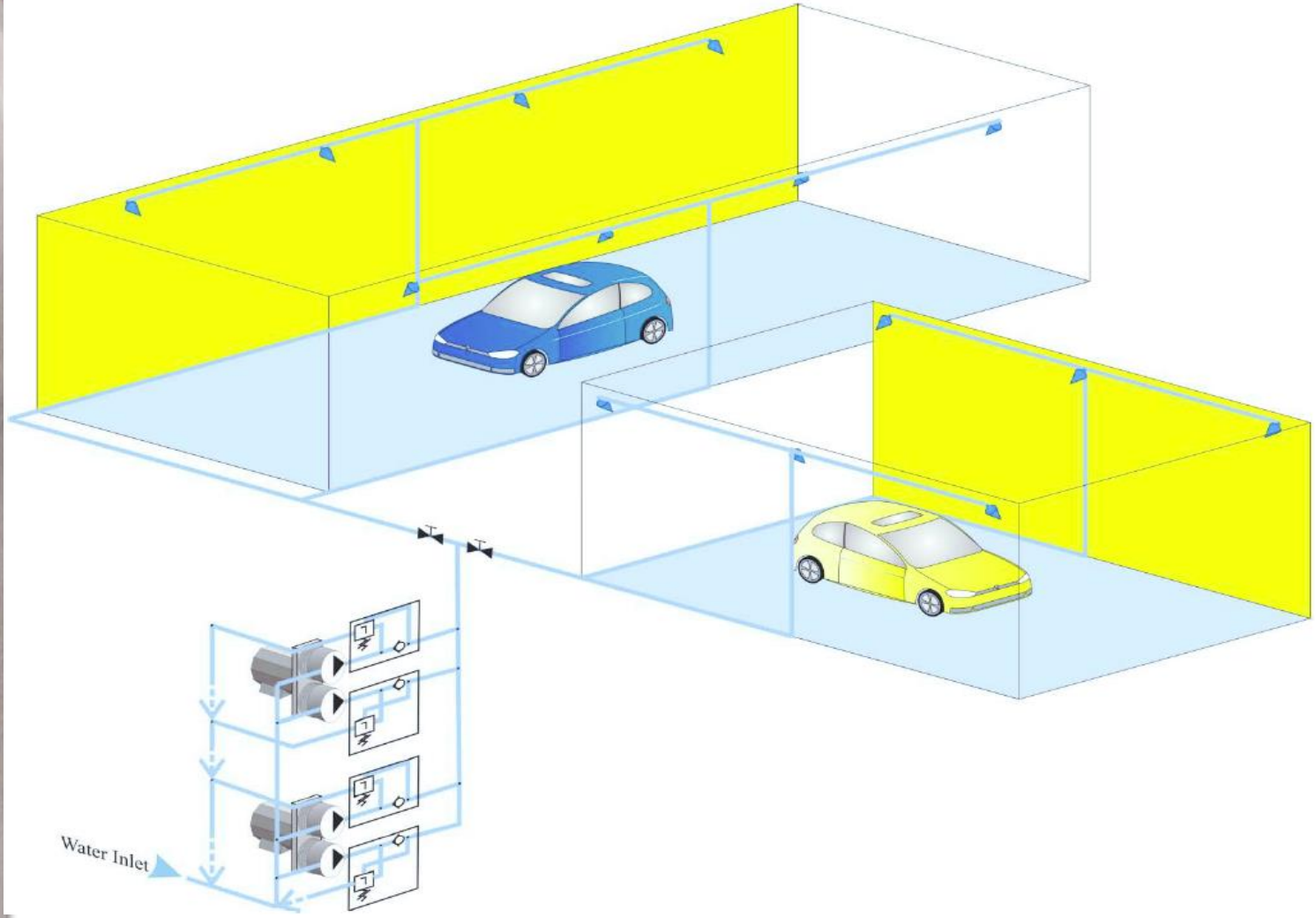


Application – Industrial Fryer

- Industrial oil cookers, also known as deep fat fryers, are a unique fire hazard in the food industry. The fire protection system needs to extinguish the flames as well as cool down the oil to prevent re-ignition
- Protection typically includes:
  - Main fryer tub
  - Product entry & exit
  - Exhaust
  - Crumb handling



Application – Paint Booth



Application – Culture Heritage

Design Principle

- System described based on application, nozzle, operation method (deluge, wet pipe, dry pipe), media type (single / twin fluid)
- Water mist systems shall be designed and installed for the specific hazards and protection objectives specified in the listing/approval
- Application parameters: height, volume, obstructions, ventilation, fuel type, fuel configuration, occupancy
- Performance objectives include one (or more) of the following: Control, Suppression, Extinguishment
- High and medium pressure systems use Darcy-Weisbach calculation method; low pressure systems use Hazen-Williams method

Fire Fighting Definitions - NFPA

Fire Control:

Limiting the size of a fire by distribution of water so as to decrease the heat release rate and pre-wet adjacent combustibles, while controlling ceiling gas temperatures to avoid structural damage.

Fire Suppression:

The sharp reduction of the rate of heat release of a fire and prevention of regrowth.

Fire Extinguishment:

The complete suppression of a fire until there are no burning combustibles

Design & Configuration

Hydraulic Calculations:

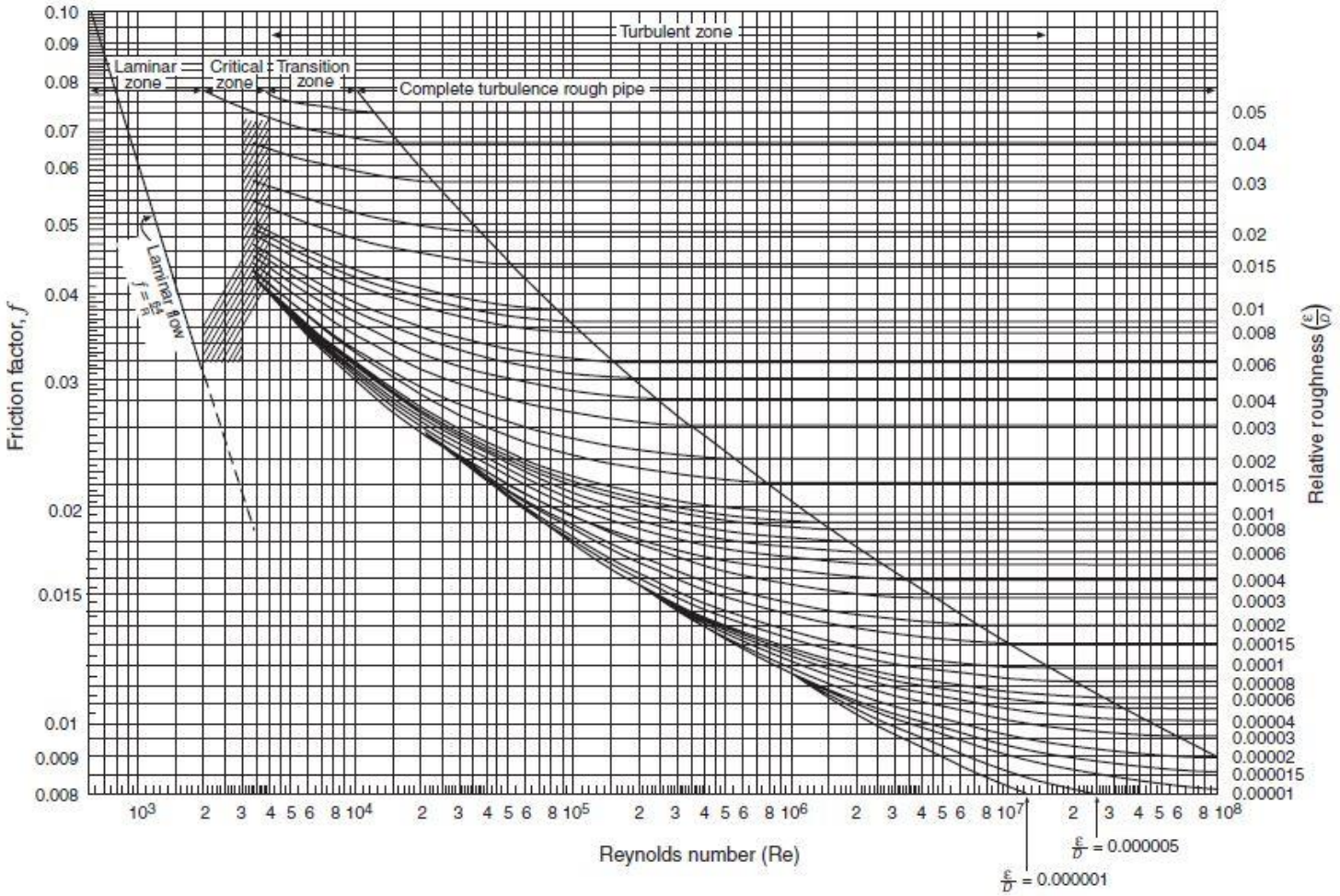
Darcy-Weisbach calculation method

$$\Delta p_m = 2.252 \frac{fLpQ^2}{d^5} \qquad Re = 21.2 \frac{Qp}{d\mu}$$

$$\text{Relative roughness} = \frac{e}{d}$$

The mixing ratio of water and gas is NOT known at all times. Assuming complete mixing of the two phases, and the Darcy-Weisbach calculation method is applied by using the average density of the mixture

Moody Diagram



Design & Configuration

- **Objective**: To reproduce the discharge characteristics recorded in the tested configurations by FM

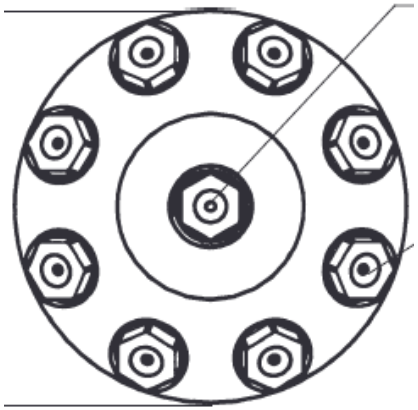
- **Challenge**: With twin fluid systems, these characteristics cannot be defined in terms of a fixed minimum pressure at the furthermost spray head.

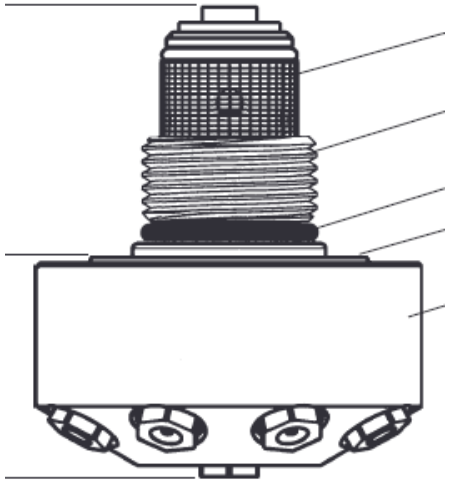
- **Solution**: The hydraulic calculations determine the pressure drop between the pump and the **largest zone**.

This calculated pressure drop must be within the allowable pressure within the proper starting pressure at the nozzle / spray heads.

Deluge Protection – Spray Heads

	5S 1MC 8MC 1000	
	Metric	English
Maximum Height	11m	36ft
K-Factor	3.9 lpm/√(bar)	0.27gpm/√(psi)
Location	Ceiling & Intermediate Levels	
Projection	Downward	
Max Spacing	4m	13.1ft
Min Distance to Walls	1.25m	4.1ft
Max Distance to Walls	4m	13.1ft
Minimum Pressure	50Bar	725 psi
Minimum Flux Density	0.14 lpm/m^3	0.001 gpm/ft^3



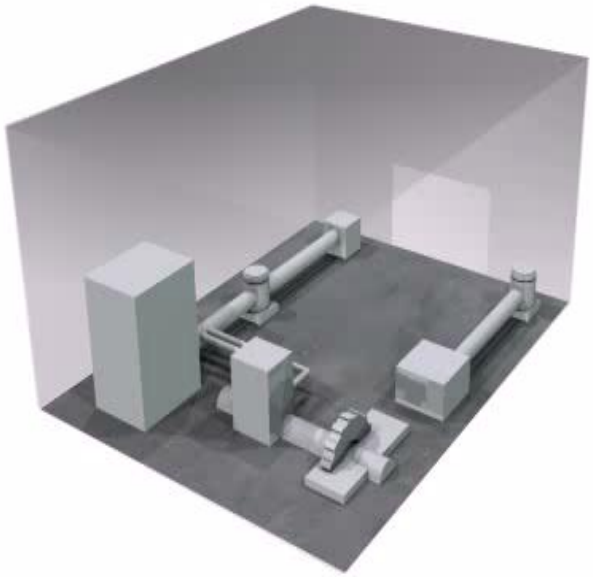


Deluge Protection

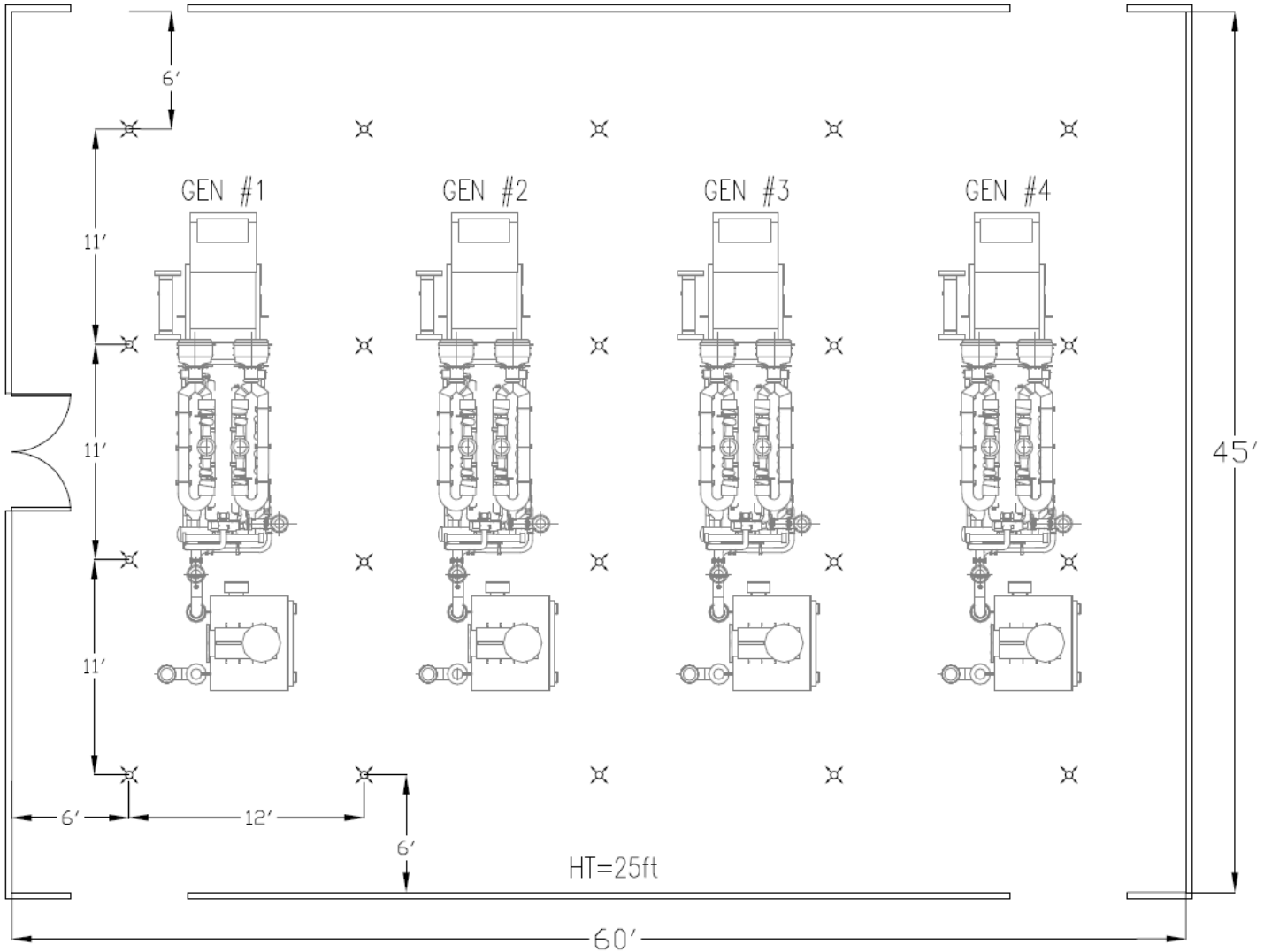
Industrial Fire

Water Mist Fire Protection System

HI-FOG® water mist fire protection



Total Flooding Machinery Space Example



Design Example

Sizing the pump

Calculating Nozzle Flow – Dependent on the K-Factor for each nozzle and pressure at the nozzle.

$$Q = K^*\sqrt{P}$$

- *Q = Nominal Flow (L/min)*
- *K-factor = Nozzle discharge coefficient (L/min/√(bar))*
- *P = Minimum operating pressure at the nozzle (Bar)*

Total Flooding Machinery Example

Volume Check

Volume = 60’ x 45’ x 25’

V = 67,500ft³ (1912m³) **< 116,500 (<3300m³)**

Choose design to be used per volume protection

Minimum Nozzle Quantity

K-factor of nozzle Selected: 3.9

Minimum Operating Pressure: 50bar

Minimum Flow per Nozzle: $Q_n = k\sqrt{(P)}$ → $3.9*\sqrt{(50)}$ → *Q_n = 27.6 lpm/nozzle*

Design Example

- Sprinkler K-Factor: 3.9 *(L/min/√(bar))*
- Sprinkler Quantity: 20 – *Total Flooding*
- Sprinkler Minimum Pressure: 50Bar

$$Q = K^*\sqrt{P}$$

Q_{nozzle} = 3.9 * √(50) → ***27.6 L/min per nozzle***

Q_{Total} = 27.6 * 20 → **552 *L/min***

NFPA Compliance = 552*110% → *607 L/min*

Flux Density: lpm/vol → 607/1912 → 0.31 lpm/m³ > 0.14lpm/m³ ✓

Water Mist Comparison

Vs. Traditional Sprinkler

Better:

Requires less water - smaller water tank, lesser water damage,

- **smaller drainage**
- **Utilizes smaller tubing - easier**

Equivalent:

- **Dimensioning of system by protected area and nozzle spacing**

Water-Mist comparison

HI-FOG® water mist fire protection

Vs. Gas systems

Better:

- **Harmless to people - immediate activation**
- **Harmless to the environment – not subjected to banning**
- **Gentle surface cooling – no reigniting**
- **Enclosure's integrity not critical – does not require enclosure integrity test**
- **Scalable**

Equivalent:

- **Dimensioning of system (total flooding) by protected volume**
- **Downside:**
- **May not extinguish small fires**

Water-Mist comparison

Vs. Foam systems

Better:

- **Harmless to people - immediate activation**
- **Harmless to the environment**
- **Less corrosive**
- **Utilizes water only- and less of it**

Video

Water-Mist benefits

- Fire-fighting ability tested and confirmed
- Fast activation
- Low Water Consumption
- No Chemical Additives
- Low Maintenance & Re-fill costs
- Environmentally Friendly
- Wide variety of applications
- Sustainable design
- System scalability

1. All commercially available water mist system performs the same as long as they have the same pressure classification? T or F
2. What are the 3 different types of water mist system applications?
3. To be defined as a water mist, a water spray for which the $D_{v0.99}$, for the flow weighted cumulative volumetric distribution of water droplet is less than _____mm
4. Which FM approval standards cover design, performance, and testing of water mist system?
5. State the calculation methods to be used for high, intermediate and low pressure water mist system.
6. What type of water mist system utilize separate piping system for each medium?
7. What are the extinguishing mechanism of water mist?
8. Water mist can be used for direct application for reactive metals & liquefied gases. T or F
9. What is the governing NFPA standard for water mist fire protection system?

Thank you

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THANK YOU