AUTOMATIC SPRINKLER
VERSUS WATER MIST SYSTEMS

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Nature of fire

Fire triangle
Nature of fire

Fire triangle

- Oxygen
- Heat
- Fuel

Solids
Liquids
Gases
Chemical
Electrical
Mechanical
Nature of fire

Remove one or more elements

How to remove heat?

With Water !!!

Fire extinguisher
Fire hoses
Fixed piping system
Fixed piping system

Brings water directly to fire

Piping distribution system with:
- Closed nozzles that open on temperature rise
- Open nozzles with separate detection system that opens a valve
Automatic sprinklers - history

- **1723** Godfrey’s Cask (chemist, UK)
- **1812** Sir William Congreve, UK; Theatre Royal London; perforated pipes with manual valves supplied by pressurized tank
- **1850-1880** perforated pipe systems in the USA, in textile mill buildings and several patents that tried to improve the operation
- **1874** Henry Parmelee, USA, CT;; device that operates automatically and would only discharge water in the area of the fire, minimizing water damage
- **1878-1881** Parmelee and Grinnell installed approx. 200,000 sprinklers; 19 fires extinguished in period
Automatic sprinklers - history

Conventional “old type” sprinkler: relative large amount of water upwards

- **1953** Standard Spray Sprinkler

- **1980** Large Drop Sprinkler Head; K160; first design on number of heads/pressure and not density/area = was the first CMSA sprinkler

- **1988** Early Suppression Fast Response (ESFR) Sprinkler; K200

Other developments: larger K factor, side-wall, extended coverage …
Automatic sprinkler systems - myths

- Are not needed as there is nothing to burn
- Are not needed as the fire department will quickly extinguish fire
- All sprinklers operate at once and cause water damage
- Sprinklers fail frequently and cause water damage
Automatic sprinklers – some characteristics

- **Type**: upright or pendent

- **Temperature rating**: from 60 to 340°C

- **Sensitivity**: how fast will sprinkler activate; RTI = Response Time Index
  standard RTI > 80; fast RTI < 50

- **K factor**: related to the orifice size through which water flows
  - Amount of water delivered by sprinkler \(Q\) = \(K \times \sqrt{\text{pressure at head}}\)

  **Example**: standard spray, \(K = 80\)  
  ESFR, \(K = 360\)  
  \(Q\) at 1 bar = 80 l/min  
  \(Q\) at 1 bar = 360 l/min
Automatic sprinklers – installation standards

- **1885** UK, John Wormald, wrote first rules for sprinkler installation
- **1896** USA, first National Fire Protection Association (NFPA) Sprinkler Standard
  - Why: systems were installed in too many different ways
  - 11 pages including sprinkler arrangement / location, valves, hangers, piping, and water supplies
- **1955** NFPA, use of spray sprinklers
- **1966** NFPA, hydraulic design was added
- **1972** NFPA the area density concept was added, design curves added

1965 – 1984 NFPA 231 storage series were added. Initially participating organizations published their own internal standards on storage

- **1968** UK, FOC rules for sprinkler installations, 29th edition
- **1990** Europe, work started in CEN on a European sprinkler standard.
Automatic sprinklers – installation standard

➢ 1991 NFPA 13, complete rewrite

➢ 1999 NFPA 13 major reorganization + 231 series + sprinkler design information from over 40 other NFA documents

➢ 2003 Europe, EN 12845 – Automatic sprinkler installations is released (175 pages)

➢ 2013 NFPA 13 – latest version, over 440 pages

Water mist systems are not covered by NFPA 13 but by NFPA 750

Several other related standards/ guides

NFPA 25: testing and maintenance
Automatic Sprinklers – other standards - guides

- FM DS 2-0 (USA)
- CEA 4001 (Europe)
- CEA 4001 VDS (Germany)
- APSAD R1 (France)
- FPA – LPC Rules incorporating BS EN 12845 (UK)
Automatic Sprinklers – approval standards

- **1886** USA, FM set up testing in
- **Around 1894** – USA, UL testing of automatic sprinkler equipment

- **1930 – 40** UL and FM formal standards to describe the test methods to be used for equipment

- Approval standards
  - UL 199 – standard automatic sprinklers (USA)
  - FM 2000 – control mode sprinklers (USA)
  - EN 12259-1 (Europe)

  - LPS 1039 (UK)
Automatic sprinklers – test centers

- Early days sprinklers were only tested on how water was distributed.
- Testing of sprinkler performance on actual fires
  - 1947 FM in Norwood, MA, USA
  - 1954 UL Northbrook, IL, USA
  - 1967 – FM - 4600 m² test center
  - 1968 – 1972 large scale rack storage tests done; tests showed limitation of ceiling only designs
- 1996 – UL – 930 m² moveable ceiling up to 14.6 m
- 2008 – FM – 2x600 m² moveable ceilings up to 18 m

CNPP - France
SP – Sweden
BRE - UK

Full scale Fire test
Automatic sprinkler system - Factors

- Objective
- What is occupancy / commodity that needs protection
- Building height
- Storage height and arrangement

- Obstructions
- System type
- Sprinkler type
- Sprinkler spacing
- Water duration

- Commissioning and acceptance tests
- Regular maintenance and inspections
- Revalidation of concept when changes occur
Water mist system – What?

From NFPA 750
- 1.2.1. ... water-based fire suppression systems that use a specific spray (mist) that absorbs heat, displaces oxygen, or blocks radiant heat to control, suppress, or extinguish fires as required by the application.

- Fog, fine spray

- Trade names: FOGTEC®, HI-FOG®, MicroDrop®, minifog ....
Water mist - history

- **1930 – 1970**: Literature reports nozzles and research on such applications.
- **1970 – 1992**: Research and testing mainly in Nordic countries with various nozzle designs and applications relating to room/passenger cabin protection and some other applications.
- **1990**: Fire on ferry ship “Scandinavian Star” with many loss of life.
- **1992**: USA, NFPA approached and initial work.

Water mist – extinguishing mechanism

- **Cooling:** of gases and flames, of fuel, of surrounding objects, pre-wetting class A materials

- **Radiant heat blocking:** prevent fire spreading to non-ignited surfaces and reduce vaporization/burning at the fuel surface.

- **Oxygen displacement:** concentration adjacent to the fuel surface by oxygen depletion and air dilution

- Potentially helps to remove products of decomposition and combustion

- Large compartments and small fires = oxygen depletion only will not work
- Tight enclosures – when release delayed – possibility of negative pressures
Water mist spray—some characteristics

- Droplet size (< 1000 µm (1 mm)) is prime factor in water mist systems!!

Factors:

- Droplet size and distribution
- Spray density (mass of water per unit volume): can be expressed in l/min/m³ OR l/min/m² (min/min)
- Spray velocity and its direction relative to the fuel source.

Above sounds simple, is however complex
Water mist systems - objectives

➢ What is objective of system?
  ▪ Cooling
  ▪ Life safety
  ▪ Fire control
  ▪ Fire suppression
  ▪ Special protection system
  ▪ Primary protection system

➢ Duration of agent discharge
  ▪ Point of discussion between the different listing agencies, consultants, insurance companies
e.g. 2 complete discharges, minimum 10 … 30 minutes, equivalent time as would be for a sprinkler system …
Water mist systems - types

- **Pressure**
  - High pressure (> 34.5 bar)
  - Intermediate pressure (>12.1 and < 34.5 bar)
  - **Low pressure (< 12.1 bar)**

- **Nozzles:** automatic, non-automatic (open type like deluge or water spray)
- **Nozzle design type**

- **Local application** = protection of equipment in a bigger compartment
- **Total compartment** = room / area protection

- wet pipe, dry pipe, deluge, pre-action

- **Single fluid, twin fluid** (e.g. water and a gas)
Water mist systems - applications

- Combustion turbines and generator enclosures
- Indoor transformers, switches circuit breakers
- Food industry: industrial oil cookers
- Wood working: wood board presses
- Computer room subfloors
- Electronic equipment, including telecommunications equipment
- Semiconductor: clean room wet benches
- Light hazard occupancies
  - Hotel rooms, museums, offices, schools
Water mist systems - advantages

- Compared to gas systems
  - Non-toxic, environmentally friendly
  - Provides cooling.
  - Less sensitive to openings in the enclosure

- Compared to sprinkler systems
  - Uses water more efficiently
  - Smaller amount of water needed
  - Less water damage
  - Can extinguish shielded fires in certain instances
Water mist – installation standards

- NFPA 750 (USA) – Standard on water mist systems
- CEN/TS14972 (2011) – water mist systems design and installation
  
- ONR CEN/TS 14972

- FM DS 4-2 (USA) – Water mist systems
- DD 8489 – (UK) commercial and industrial water mist systems
- APSAD D2 – (France) technical document

Not design standards
Water mist – approval standards

- FM approval standard 5560 (2009) – water mist systems
- FM approval standard 5580 (2009) – hybrid (water and inert gas) systems
- ANSI/UL 2167 (2004), USA
- IMO (International Maritime Organization) standards

2 parts: component testing and fire testing

- Effectiveness to be proven through fire tests for hazard type and configuration
- Caution: Fire tests for certain application might be different in the various standards

Design and installation manuals of the manufacturers’ are important
Sprinkler – water mist – common features

➢ **Use water for cooling and radiant heat blocking**

➢ Fixed piping systems with open or closed nozzles

➢ Hydraulic design methods

➢ Sprinkler/nozzle spacing and obstruction rules

➢ System and sprinkler/nozzle type

➢ Water duration

➢ Installation and approval standards

➢ (Large) scale testing

➢ Commissioning and acceptance tests

➢ Regular maintenance and inspections

➢ Revalidation of concept when changes occur

➢ Procedures

**Common not to be confused with same !**
Sprinkler – water mist - differences

Water mist

- Small droplets obtained by a variety of design of nozzles with small K factors
- Combination of cooling, radiant heat block, oxygen depletion. Importance of each depends on application
- Uses considerable less water in it’s design
- **Means less forgiving with mistakes or deviations**
- Do not extrapolate hazard type, volume, room height for which system was approved

Sprinklers

- Technology has proven successful over the last 125 years
- Can be used to protect large variety and combination of hazards
- Classical designs somewhat forgiving, but not with high challenge fires
Both system types have much in common but are also different in many aspects.

However, they have both the same goal:

Prevent this
THANK YOU

OBRIGADO

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