Practical experience from actual water mist installations

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Personal introduction

- Graduated Fire Protection Engineer from University of Lund in 1989.
- Employment as a fire protection consultant 1989-1991.
- Employed at SP Fire Research since October 1991.
- Joined my first IMO Fire-Protection Sub-Committee meeting, FP38 in 1993.
- Participated in the technical committee that developed the first edition of NFPA 750, published in 1996.
- Participated in the CEN committee on water mist fire protection systems 1998-2010.

SP Rapport 2014:30, Water mist fire protection systems – an updated state-of-the-art report

- An update of SP Rapport 2001:26, ”Släcksystem med vattendimma – en kunskapssammanställning” .
- Describes technological developments which have been seen in recent years.
- Gather experience and results from confirmatory experiments for different applications.
- Provide a summary of the installation requirements and testing methods with its application.
- **Provide examples of both good and bad experience from real installations.**
- Note: Only available in Swedish.

”Water mist”. In this case 26 liter/min at 100 bar, equal to 2.1 mm/min.

High-pressure system, 60 bar.

High-pressure system, 60 bar.

Low-pressure system, approximately 8 bar.

Low-pressure system, approximately 8 bar.


Psalm. 150. V. 6.

Examples of both good and bad experience from real installations

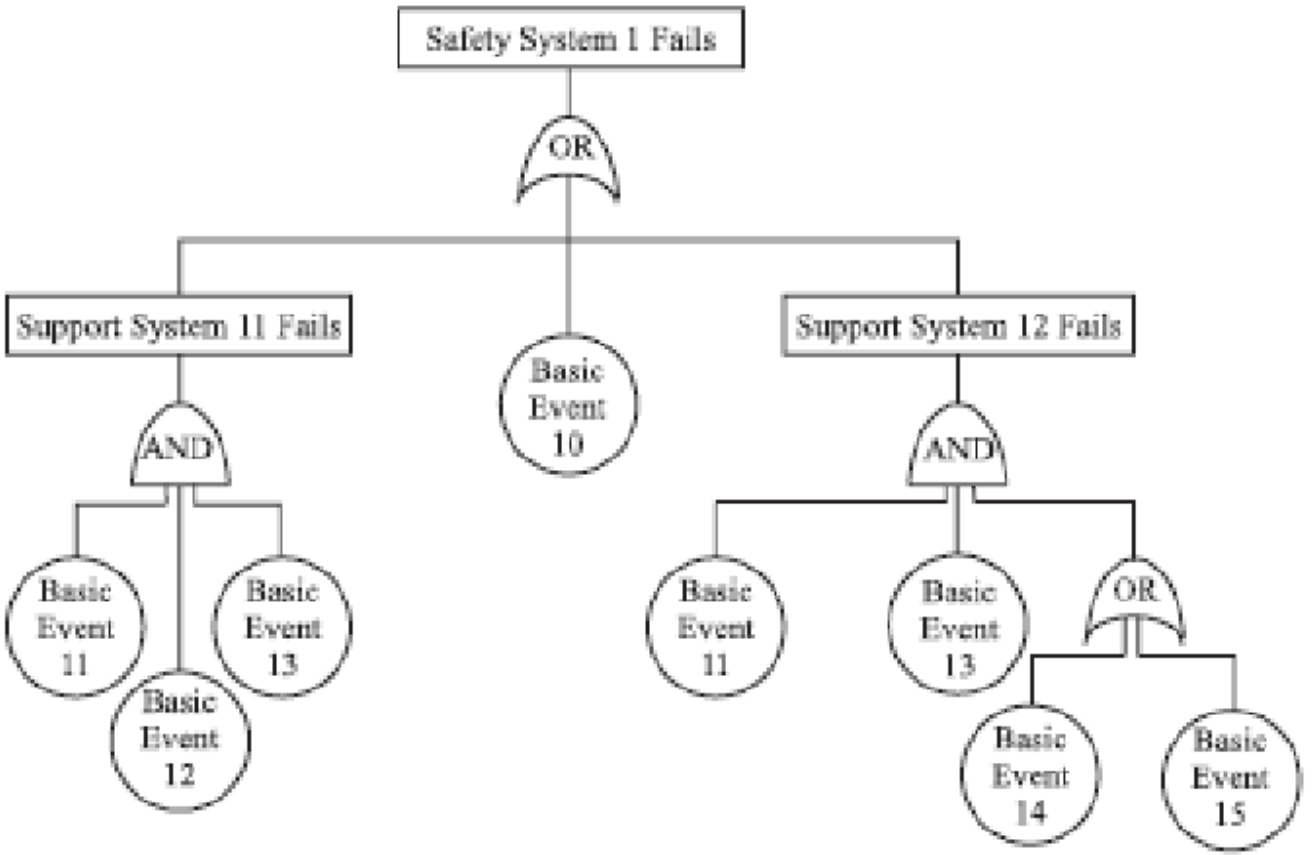
Why?

- Lessons learned can improve the design of water mist systems, laboratory test procedures, installation practices, maintenance procedures, etc.

The examples were provided through a literature survey and by contacts with Swedish fire safety system inspectors.

Water mist system reliability

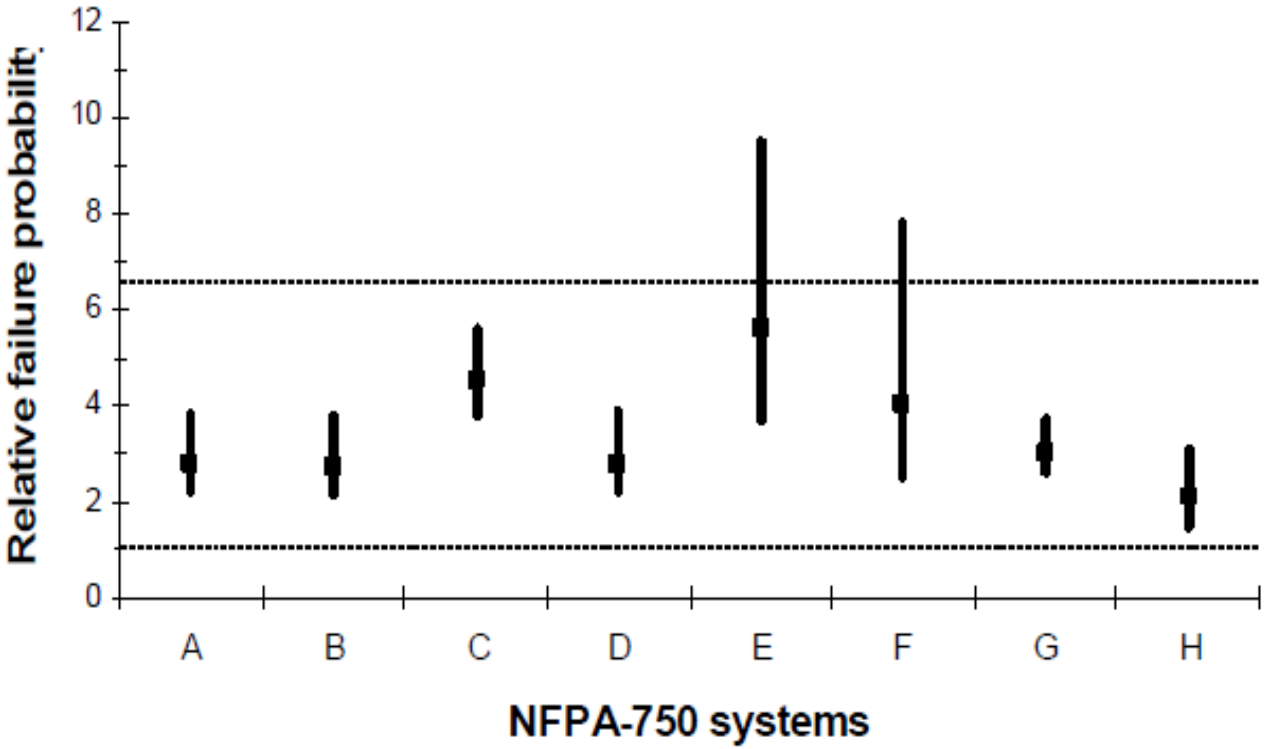
- To date, there is not enough field experience to judge system reliability.
- Estimation of system reliability need to be based on fault tree analysis.



Fault tree analysis for fire protection systems on passenger ships

Type of system	Reliability as a function of maintenance interval	
	Monthly	Yearly
Traditional sprinkler system	99.5% ± 0.3%	93.7% ± 3.6%
Water mist system (generic)	96.8% ± 1.8%	69% ± 16%
Water mist system (improved)	98.6% ± 0.8%	84.7% ± 8.3%

Fault tree analysis of eight different systems (FM Global)



A: High pressure and gas driven system with stored water.
B: High pressure and gas driven with multiple accumulator units.
C: Low pressure twin fluid water mist system.
D: Single fluid mist system.
E: Pump driven water mist system.
F: Positive displacement pump assembly with unloader valves on each pump and pressure relief valve on discharge manifold.
G: Gas pump unit for machinery spaces and gas turbine enclosure.
H: Gas pump for light hazard applications.

Examples of both good and bad experience from real installations

Good experience example

- The fire on board the Star Princess.

Bad experience examples

- Problems with automatic nozzles.
- Two serious incidents associated with the storage of pressurized inert gases.
- Clogging of system filter.
- Clogging of nozzles.
- Change of installation data sheet after inspectors remark.

Star Princess fire

- Fire broke out on 23 March 2006, at about 3 am.
- Started on balcony, amidships, on the port side of the ship.
- 2690 passengers and 1123 crew members on board.
- 79 cabins destroyed and a further 204 damaged.
- One passenger died due to inhalation of smoke and toxic gases.
- Thirteen other passengers suffered significant smoke inhalation.

Star Princess fire

- The high-pressure system was designed for an operating area of 280 m^2 (about 18 nozzles) at an operating pressure of 60 bar.
- Approximately 168 nozzles activated.
- The system was operating for four hours.
- The system pressure was approximately 48 bar, using two regular pump units and a third pup unit that was manually started.
- About 300 tons of water was distributed over three decks and three main verical fire zones.
- Eight nozzles did not activate properly. For seven of them, this was due to damages to the glass bulbs.
- Still, the system probably prevented a major disaster!

Problems with automatic nozzles (survey by DNV)

In 2012, Det Norske Veritas did a survey on four passenger ships older than ten years. The results showed that:

- Between 30% and 67% of the nozzles that were tested did not activate.
- Problems were associated with one particular make and type of nozzle.
- Further studies were recommended.

Problems with automatic nozzles (survey by Bahamas)

Nozzles on 80 ships were tested with a small sample of 20 nozzles. On 24 ships of 80, non-functional nozzles were found.

- On 3 of these 24 ships, a large sample did not indicate any problems.
- On 12 of these 24 ships, all nozzles within one or more sections needed to be replaced.
- On 9 of these 24 ships, no result are available (August 2014).
- On one ship, the ship owner decided to replace all nozzles, based on the results from the small sample.

Conclusion:

- Single, non-functional nozzles were found on 24 of 80 ships (30% of the ships).
- Multiple numbers of non-functional nozzles were found on 12 of 80 ships (15% of the ships).

Problems with automatic nozzles (survey by Bahamas)

- Nozzles from four different manufacturers.
- Both low- as well as high-pressure systems.

Primarily three different causes:

- Blockage of the internal filter with mineral deposits.
- Build-up of scale and mineral deposits on the internal components.
- Corrosion of the internal components.

Two manufacturers have recognized the root cause to water quality.

Problems with automatic nozzles (survey by Bahamas)

Suggestion on how to address these problems:

- Regular field sampling testing of nozzles should be required.
- The minimum required water quality need to be specified by the manufacturer.
- It should be possible to assess the water quality in the header tank, pump unit and piping of each section against the manufacturer's water quality requirements.
- It should be possible to fully drain and flush all sections and branch lines, without the removal of nozzles.

Two serious incidents associated with the storage of pressurized inert gases

- Gas driven pump unit located in a 10 m^2 room in basement.
- Access only possible via a stair from the floor above.
- Approximately 30 Nitrogen cylinders.

Incident 1

Accidental activation of the system. Due to a technical failure, all gas entered the room. The caretaker entered the room but had to evacuate.

Incident 2

A pipe coupling in the room broke.

A fireman entered the room but had to evacuate.

The cutting ring of the coupling was mounted wrong.

Clogging of the system filter

- A pump unit in a building was tested.
- After a few minutes, the pump unit stopped. The reason was that the system filter was clogged.
- The underlying reason was work on the municipal water supply.

Comment: System filters need to be dimensioned for non-clean water.

Clogging of nozzles

- An installer suggested (for cost reasons) that the system should be connected to the water supply for the sprinkler system of the building.
- Results: Nozzles were clogged as the water quality was not high enough.

Comment: Water mist systems require a higher water quality than traditional sprinklers.

Change of installation data sheet after inspectors remark

- A common remark during inspections is that nozzles are installed at longer spacing than specified.
- Instead of moving the nozzle(s) or installing additional nozzles, one company revised its installation data sheet.
- The background material for the revision was not provided.

Comment: Any change should be verified, documented and approved by third party.

Lessons learned?

- System reliability is an issue, but there are limited field experience.
- Fault tree analysis indicate a higher probability for failure as compared to traditional sprinkler systems.
- Nozzle functionality is an issue. Regular field sampling testing should be required.
- Water quality is an issue. Means for control, drainage and flushing need to be provided.
- Clogging is an issue. Relates to water quality and the filter design.
- Rooms with pressurized inert gases should be accessed directly from the outside.
- Can installation data sheets be trusted?

Brandposten

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