Practical experience from actual water mist installations. What can be learnt?

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

- 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.
Examples of both good and bad experience from real installations

Why? Because lessons learned can improve:

- Laboratory test procedures.
- The design of water mist systems.
- Installation practices.
- Control, inspection and maintenance procedures.

The examples were provided through a literature survey and by contacts with Swedish fire safety system inspectors.
Examples of both good and bad experience from real installations

Good experience example
- The fire on board the Star Princess.

Bad experience examples
- System reliability.
- Problems with automatic nozzles.
- Two serious incidents associated with the storage of pressurized inert gases.
- Clogging of system filters.
- Clogging of nozzles.
- Change of installation data sheet after inspector’s remark.
- Mixing of installation standards.
- Separation of pipe-couplings during pressure tests.
- Etc.
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 m² (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 vertical fire zones.

- Eight nozzles did not activate properly. For seven of them, this was due to defective glass bulbs.

Still, the system probably prevented a major disaster!
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

<table>
<thead>
<tr>
<th>Type of system</th>
<th>Reliability as a function of maintenance interval (with Std)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Monthly</td>
</tr>
<tr>
<td>Traditional sprinkler system</td>
<td>99.5% ± 0.3%</td>
</tr>
<tr>
<td>Water mist system (generic)</td>
<td>96.8% ± 1.8%</td>
</tr>
<tr>
<td>Water mist system (improved)</td>
<td>98.6% ± 0.8%</td>
</tr>
</tbody>
</table>

Comparable with sprinkler field experience from Australia and New Zealand

Comparable with sprinkler field experience in general
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.
“Sprinkler recalls” – Central Omega sprinkler

65 different models – using O-Ring type water seals – totaling approximately **35 million** Central fire sprinklers.

Another example: Wormald Type R (manufactured 1982 – 1987)
Defective sprinkler glass bulbs – the problem
Defective sprinkler glass bulbs – the solution

Note: All sprinkler manufacturers have similar instructions.
Two serious incidents associated with the storage of pressurized inert gases

- Gas driven pump unit located in a 10 m² 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 filters

Case 1

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

Case 2

- During the weekly testing of a pump unit, the system filter is clogged and need to be cleaned.
- The system is connected to the underside (= sediments) of a potable water pipe.

Comment: System filters need to be better designed and proper water quality assured.
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 good 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 a larger 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.
Mixing of different installation standards

Claim

- The system is FM Approved for HC-1 occupancies (previously denoted Light Hazard occupancies).

Requirements

- FM approved components.
- Designed and installed in accordance with FM Data Sheets 3-26.

Design requirements (examples)

- Design area: 140 m² but never less than nine nozzles.
- 950 liter/min water capacity and hoses for manual fire-fighting.

In practice

- Other system components were used.
- Pump capacity for less number of nozzles.
- No water for manual fire-fighting.
Improper system solutions

Case 1
- During commissioning of a deluge system, a coupling broke and caused water damaged.
- The inspection revealed that an “approved” system solution was offered – another installed.

Case 2
- During commissioning of a deluge system, a coupling broke and caused water damaged.
- The inspection revealed that the system certificate was not applicable to the fire hazard and the room size was too large.
- Water was supplied from a sprinkler water tank with a regular steel pipe connection, resulting in clogging of the system filter.

Comment: Third party input is desired prior installations.
What can be learnt?

**System reliability**
- Limited field experience.
- Fault tree analysis indicate a higher probability for failure as compared to traditional sprinkler systems.
- Shorter periodical control and maintenance intervals may be a solution in practice.

**Nozzle functionality**
- Need for revision of laboratory test procedures.
- Regular field sampling testing should be required.
- Nozzle glass bulbs are indeed very vulnerable.
- Learn from sprinkler industry!
What can be learnt?

**Water quality – nozzle and filter clogging**

- Water quality need to be better described and supervised.
- Improved filter designs necessary.
- Better means for system drainage and flushing.

**Personnel safety**

- Rooms with pressurized inert gases should be accessed directly from the outside.
What can be learnt?

System integrity - pressure testing

- Material defects?
- Poor training?

Confidence

- Change of data sheets after inspector’s remarks, improper system solutions, mixing of installation standards, etc. is not acceptable!
We have all a responsibility!

- Manufacturers.
- Designers.
- Installers.
- Testing laboratories.
- Approval bodies.
- Standardization bodies.
- Regulators.
- Authorities.
- End-users.
Brandposten – The newsletter from SP Fire Research

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