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

- 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.

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.

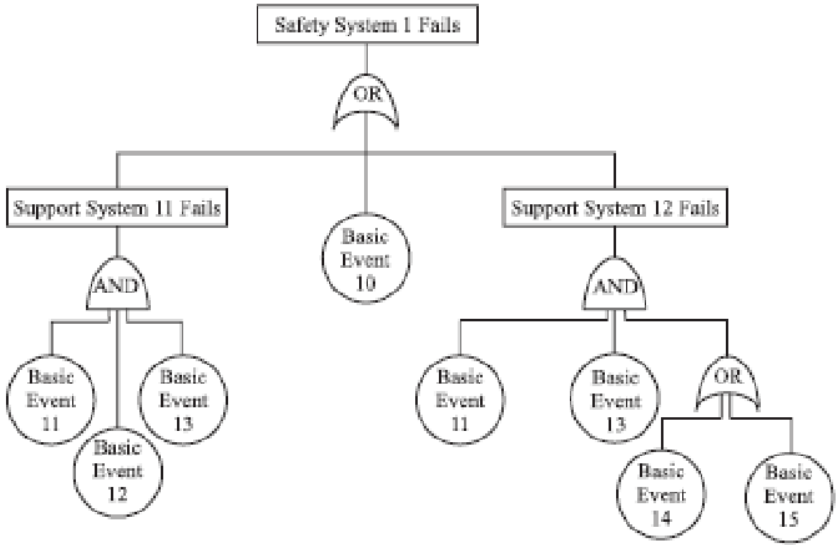
Star Princess fire

- The high-pressure system was designed for an operating area of 280 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 vertical fire zones.
- Eight nozzles did not activate properly. For seven of them, this was due to defective glass bulbs.

<u>Still, the system probably prevented a major disaster!</u>

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 (with Std)	
	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%

Comparable with sprinkler field experience from Australia and New Zeeland

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.

Manufactured 1982 – 2000.

Another example: Wormald Type R (manufactured 1982 – 1987)

SAFETY ACTION NOTICE

By arrangement with the NHS in Scotland Estates Environment Forum

ATLAS FIRE AND WORMALD SPRINKLER SYSTEMS WITH 'R' TYPE HEADS : 'O' RING DEGRADATION

SAN(SC)99/31
4 OCT 1999
Estates
Page 1 of 2 Pages

SUMMARY

'R' type sprinkler heads installed by Atlas Fire or Wormald during the period 1982 to 1987 (and possibly later) may require higher than specified water pressure to operate the system. 'R' type sprinkler heads should be changed to 'A' type.

BACKGROUND

1. 'R' type sprinklers installed by Atlas Fire Engineering Limited or Wormald Ansul (UK) Ltd, trading as Wormald Fire Systems, during the period 1982 to 1987 (and possibly later) require higher than specified water pressure to operate the system. This may be due to the incorporation of an 'O' Ring seal which has degraded, probably due to age.

2. Although there have been no incidents reported where an 'R' type head has failed to operate in a fire, Atlas Fire and Wormald have advised that they are attempting to locate systems fitted with 'R' type heads. The 'R' type is identified as being larger with a thicker frame than the 'A' type as shown in the appendix.

3. Atlas Fire and Wormald will arrange, where required, a survey to identify all 'R' type sprinkler heads and organise their replacement during normal hours at no cost to NHS establishments.

ACTION

4. This notice should be brought to the attention of all appropriate managers and staff.

5. Sprinkler systems installed by Atlas Fire or Wormald should be examined for 'R' type sprinkler heads, identified by reference to the appendix. If any are found, arrangements should be made to have premises surveyed by Atlas Fire and/or Wormald who will replace 'R' type sprinklers with 'A' type.

6. Sprinkler systems in healthcare premises should be designed and installed in accordance with NHS in Scotland : *Firecode*, British Standard BS5306 Part 2: 1990 *Fire extinguishing installations and equipment on premises*; and *Rules for automatic sprinkler installations* issued by the Loss Prevention Council.

ENQUIRIES

Further information and replacement details are available from:

Atlas Fire Helpdesk : 0800 917 6276
Wormald Helpdesk : 0800 083 0125

Suggested Distribution	Accomodation Officers	Estates/Facilities	Fire Prevention Officers
Health Centres	Hospices	Registered Nursing Homes	Risk Management
Safety Officers	Safety Representatives		

SCOTTISH HEALTHCARE SUPPLIES
Gyle Square Edinburgh EH12 9EB
A Division of the National Service Scotland for NHSScotland

FAX: 0131 314 0722 E-MAIL: iric@sbs.csa.scot.nhs.uk

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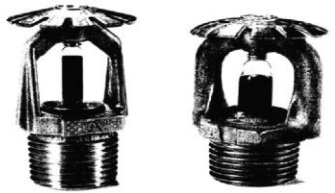
APPENDIX

NEWER 'A' TYPE SPRINKLER HEAD COMPARED WITH OLDER 'R' TYPE SPRINKLER HEAD



'A' type head (left). The 'R' type head (right) has a larger, thicker frame.

SCOTTISH HEALTHCARE SUPPLIES
Gyle Square Edinburgh EH12 9EB
A Division of the National Service Scotland for NHSScotland

This notice was obtained from the INCIDENT REPORTING & INVESTIGATION CENTRE (public) website
http://www.nhsscotland.com/shn/hazards_safety/adverse_p.html
FAX: 0131 314 0722 E-MAIL: iric@sbs.csa.scot.nhs.uk

Defective sprinkler glass bulbs – the problem

Defective sprinkler glass bulbs – the solution

Page 1 of 4

VIKING | BULLETIN | CARE AND HANDLING OF SPRINKLERS

The Viking Corporation, 210 N Industrial Park Drive, Hastings MI 49058
Telephone: 269-945-9501 Technical Services: 877-384-5464 Fax: 269-818-1680 Email: techsvcs@vikingcorp.com

SPRINKLERS ARE FRAGILE - HANDLE WITH CARE!

General Handling and Storage:

- Keep sprinklers in a cool, dry place.
- Protect sprinklers during storage, transport, handling, and after installation.
- Use the original shipping containers. DO NOT place sprinklers loose in boxes, bins, or buckets.
- Keep sprinklers separated at all times. DO NOT allow metal parts to contact sprinkler operating elements.

For Pre-Assembled Drops:

- Protect sprinklers during handling and after installation.
- For recessed assemblies, use the protective sprinkler cap (Viking Part Number 10364).

Sprinklers with Protective Shields or Caps:

- DO NOT remove shields or caps until after sprinkler installation and there no longer is potential for mechanical damage to the sprinkler operating elements.
- **Sprinkler shields or caps MUST be removed BEFORE placing the system in service!**
- Remove the sprinkler shield by carefully pulling it apart where it is snapped together.
- Remove the cap by turning it slightly and pulling it off the sprinkler.

Sprinkler Installation:

- DO NOT use the sprinkler deflector or operating element to start or thread the sprinkler into a fitting.
- **Use only the designated sprinkler head wrench!** Refer to the current sprinkler technical data page to determine the correct wrench for the model of sprinkler used.
- DO NOT install sprinklers onto piping at the floor level.
- Install sprinklers after the piping is in place to prevent mechanical damage.
- **Take care not to over-tighten the sprinkler or damage its operating parts!**
- DO NOT allow impacts such as hammer blows directly to sprinklers or to fittings, pipe, or couplings in close proximity to sprinklers. Sprinklers can be damaged from direct or indirect impacts.
- DO NOT attempt to remove drywall, paint, etc., from sprinklers.

CORRECT (Original container used) | INCORRECT (Placed loose in box)

CORRECT (Protected with caps) | INCORRECT (Protective caps not used)

CORRECT (Piping is in place at the ceiling) | INCORRECT (Sprinkler at floor level)

CORRECT (Special installation wrenches) | INCORRECT (Designated wrench not used)

⚠ WARNING

Any sprinkler with a loss of liquid from the glass bulb or damage to the fusible element should be destroyed. Never install sprinklers that have been dropped, damaged, or exposed to temperatures exceeding the maximum ambient temperature allowed. Sprinklers that have been painted in the field must be replaced per NFPA 13. Protect sprinklers from paint and paint overspray in accordance with the installation standards. Do not clean sprinklers with soap and water, ammonia, or any other cleaning fluid. Do not use adhesives or solvents on sprinklers or their operating elements.

Refer to the appropriate technical data page and NFPA standards for complete care, handling, installation, and maintenance instructions. For additional product and system information Viking data pages and installation instructions are available on the Viking Web site at www.vikinggroupinc.com.

Form No. F_091699 Rev 15.1

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The Viking Corporation, 210 N Industrial Park Drive, Hastings MI 49058
Telephone: 269-945-9501 Technical Services: 877-384-5464 Fax: 269-818-1680 Email: techsvcs@vikingcorp.com

PROTECTIVE SPRINKLER SHIELDS AND CAPS

General Handling and Storage:

Many Viking sprinklers are available with a plastic protective cap or shield temporarily covering the operating elements. The snap-on shields and caps are factory installed and are intended to help protect the operating elements from mechanical damage during shipping, storage, and installation. NOTE: It is still necessary to follow the care and handling instructions on the appropriate sprinkler technical data sheets* when installing sprinklers with bulb shields or caps.

WHEN TO REMOVE THE SHIELDS AND CAPS:

NOTE: SHIELDS AND CAPS MUST BE REMOVED FROM SPRINKLERS BEFORE PLACING THE SYSTEM IN SERVICE!

Remove the shield or cap from the sprinkler only after checking all of the following:

- The sprinkler has been installed*.
- The wall or ceiling finish work is completed where the sprinkler is installed and there no longer is a potential for mechanical damage to the sprinkler operating elements.

SHIELDS AND CAPS MUST BE REMOVED FROM SPRINKLERS BEFORE PLACING THE SYSTEM IN SERVICE!

Figure 1: Sprinkler shield being removed from a pendent sprinkler. | Figure 2: Sprinkler cap being removed from a pendent sprinkler. | Figure 3: Sprinkler cap being removed from and upright sprinkler.

HOW TO REMOVE SHIELDS AND CAPS:

No tools are necessary to remove the shields or caps from sprinklers. DO NOT use any sharp objects to remove them! **Take care not to cause mechanical damage to sprinklers when removing the shields or caps.** When removing caps from fusible element sprinklers, use care to prevent dislodging ejector springs or damaging fusible elements. NOTE: Squeezing the sprinkler cap excessively could damage sprinkler fusible elements.

- To remove the shield, simply pull the ends of the shield apart where it is snapped together. Refer to Figure 1.
- To remove the cap, turn it slightly and pull it off the sprinkler. Refer to Figures 2 and 3.

NOTICE Refer to the current sprinkler technical data page to determine the correct sprinkler wrench for the model of sprinkler used.

⚠ WARNING Never install sprinklers that have been dropped, damaged, or exposed to temperatures in excess of the maximum ambient temperature allowed.

* **Refer to the appropriate current technical data pages for complete care, handling, and installation instructions. Data pages are included with each shipment from Viking or Viking distributors. They can also be found on the Web site at www.vikinggroupinc.com.**

Form No. F_091699 Rev 15.1

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 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 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 m^2 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

www.sp.se