

High-pressure water mist systems in road tunnels – Background and long term experiences

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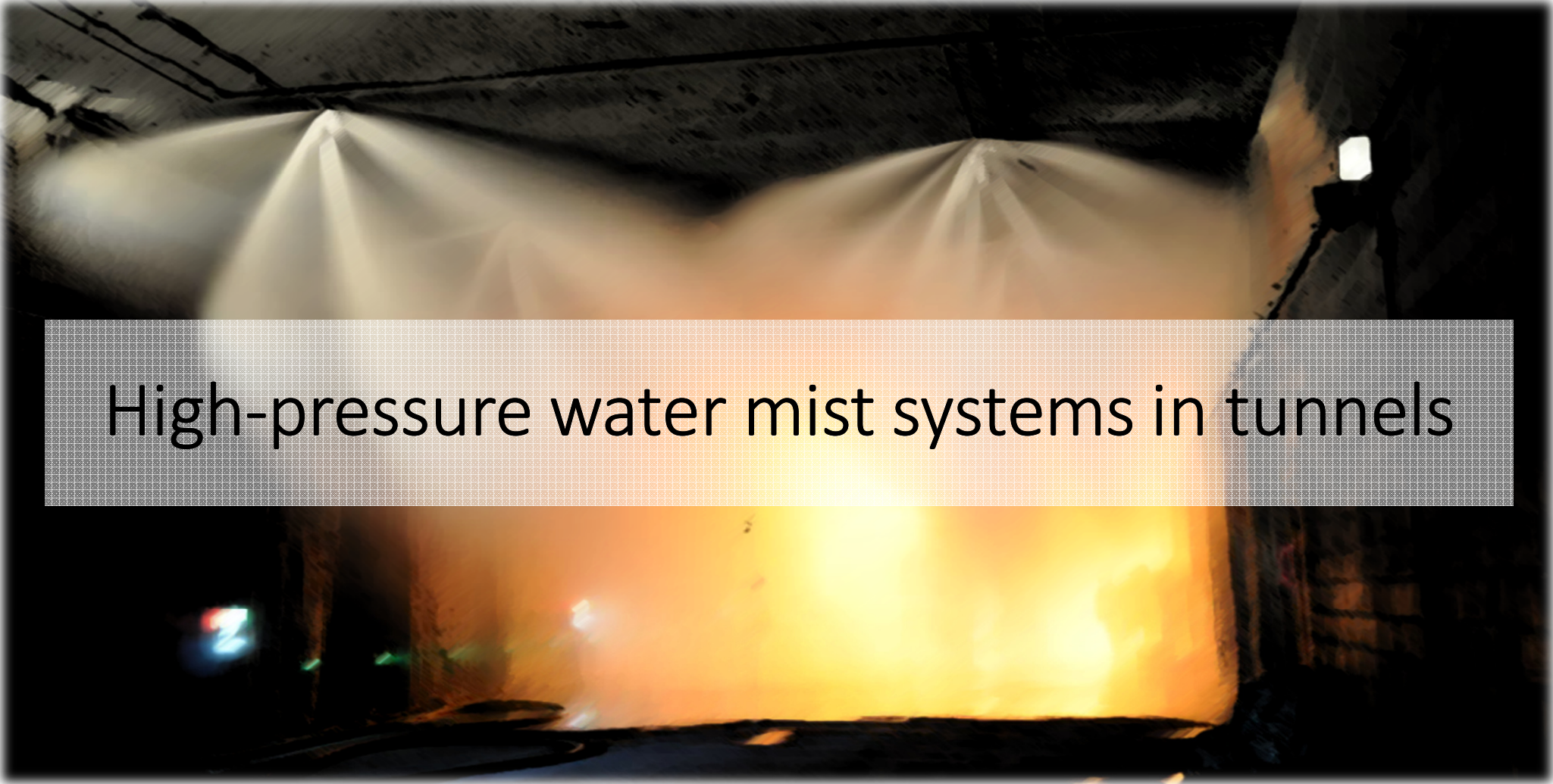
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Outline of presentation

- High-pressure water mist systems in tunnels
 - Background and research
 - Fire protection objectives
 - View of standardisation

- Reliability of high-pressure water mist system
 - Technical development
 - Performance and operational reliability
 - Guidance for ensuring operational reliability

- Case study – Virgolo tunnel (Brennero Highway, Italy)
 - Basic information
 - Recent emergency exercise in October 2014

A photograph of a tunnel fire suppression system in operation. Two large, powerful jets of white water mist are being discharged from nozzles mounted on the ceiling of a dark tunnel. The mist is directed towards a large, intense fire burning on the floor of the tunnel. The fire is bright orange and yellow, with thick smoke rising. The tunnel walls are dark and textured, and the ceiling has some visible wiring and structural elements. The overall scene is dramatic, highlighting the effectiveness of the mist system in controlling a major fire.

High-pressure water mist systems in tunnels

High-pressure water mist systems in tunnels - Background

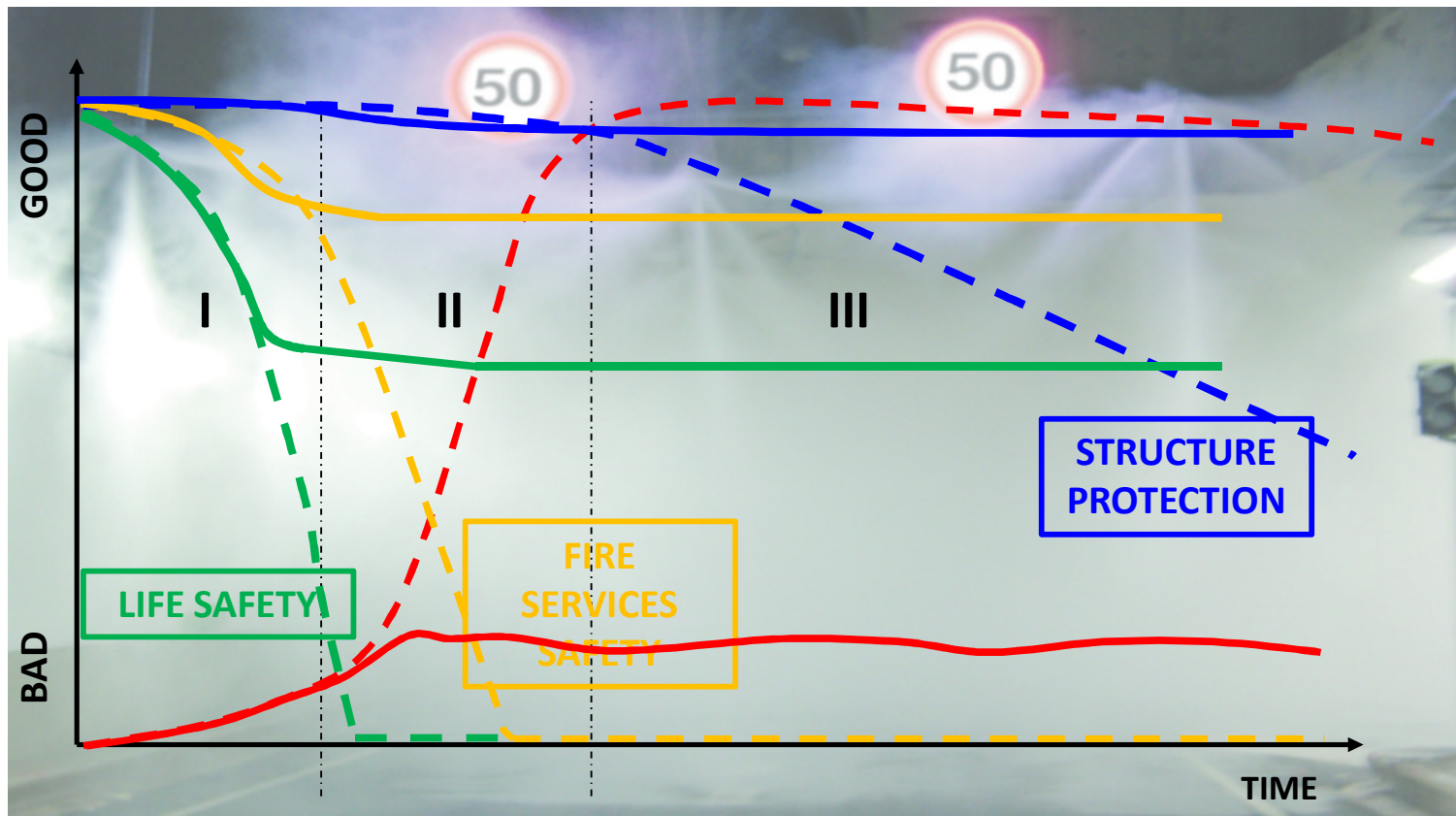
- The result of major fires and resulted fire research programs in Europe:
 - Different technologies were tested to mitigate increased/realised fire risk in tunnels
 - High-pressure water mist systems were noticed to be extremely efficient

- Technological benefits:
 - Performance vs. pumped flow rates
 - Small/limited size of pipes -> cost benefit (stainless steel)
 - Technology developed solely for tunnels



High-pressure water mist systems in tunnels

Design objectives



High-pressure water mist systems in tunnels —

Function in practice



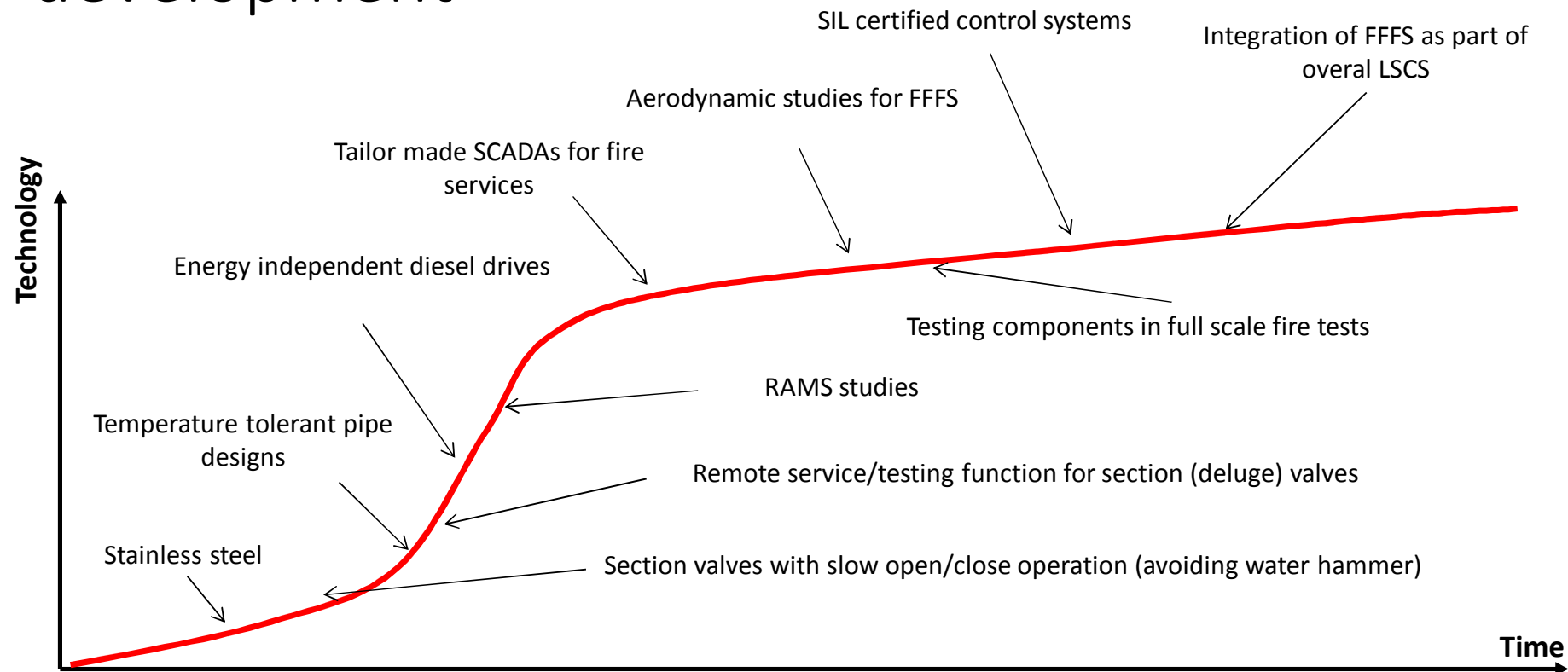
High-pressure water mist systems – View of standards

- Missconceptions towards fixed fire fighting systems in tunnels
 - PIARC was of the opinion that FFFS are rather dangerous than providing any benefits
 - Changed drastically and PIARC has/will publish additional material about FFFS
- Design fires
 - Design fires have increased significantly during last 15 years
 - HGV (heavy goods vehicle), 30MW -> 100+MW (main stream)
 - This has major impact for different fire mitigation methods
- FFFS is part of some international tunnel safety standards, e.g. NFPA502

A 3D bar chart with a blue grid background. The chart shows four bars of increasing height from left to right. A large, light blue 3D arrow points upwards and to the right, following the trend of the bars. The text "Technological development and reliability" is overlaid in the center of the chart.

Technological development and reliability

High-pressure water mist systems – Technology development



FFFS technology has developed a lot in recent years!

High-pressure water mist systems – Reliability (performance/operational)

- Performance reliability

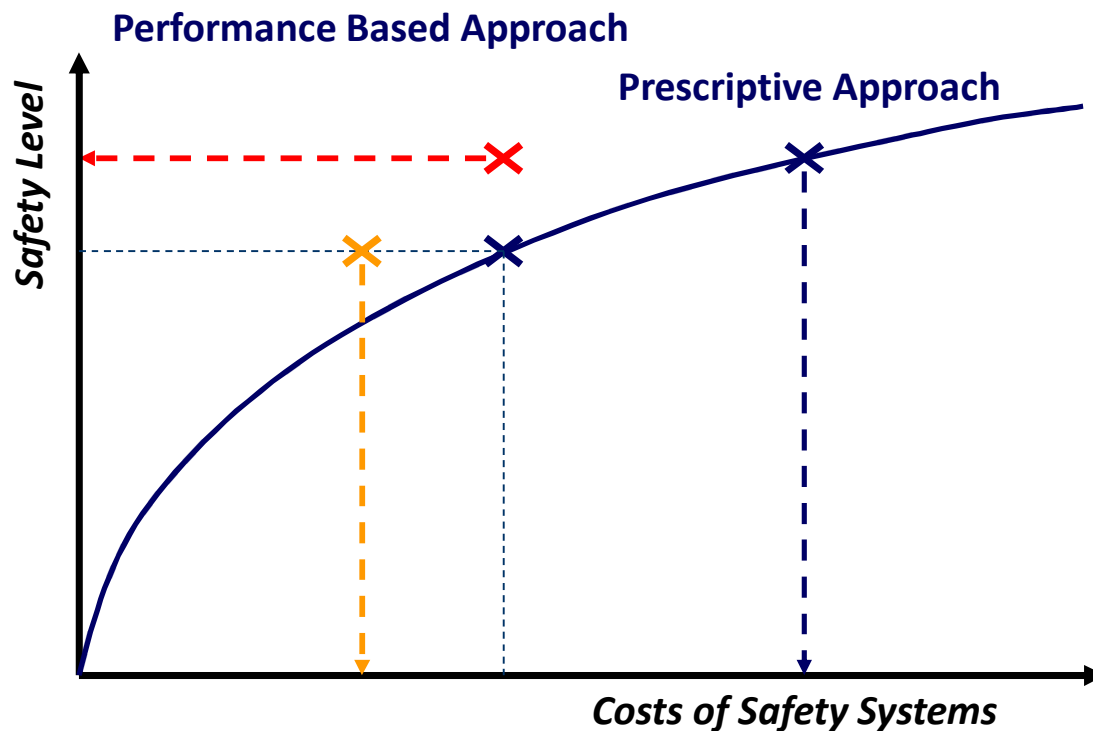
- Is system suitable tested to expected real fires?
 - Full scale fire tests
 - Design fire size
 - Detection / operation
 - Nozzle parameters
- Are the achieved results acceptable for the tunnel?

- Operational reliability

- Is system operational when needed?
- How reliable is the system and what are the weakest points?
- Is water mist system connected to other systems in reliably way?
- Is the water mist system operated in correct way?

High-pressure water mist systems – Compensation (trade-offs)

- Compensation (trade-off) is the common trend when using water mist systems



See more (e.g. all reports):

WWW.SOLIT.INFO



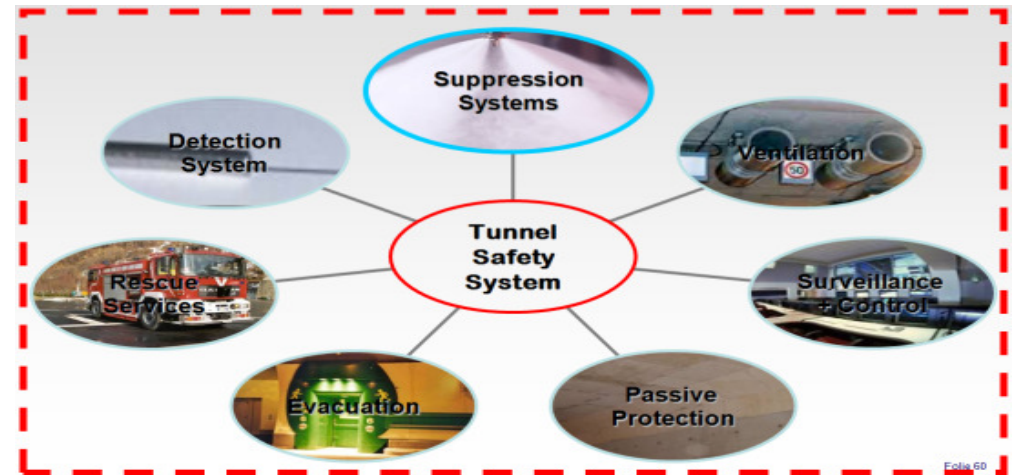
High-pressure water mist systems – Operational reliability guidance

- Making sure that right tools are used for designing reliable system
 - Right design standards (materials, functions, design rules)
- Making sure that system is integrated properly to other safety systems
 - Holistic approach to tunnel safety
- Making sure that system is properly operated
 - Avoiding fault alarms
- Making sure that system is maintained to keep it reliable
 - Right components, materials, etc.

High-pressure water mist systems – Operational reliability guidance

- FFFS is connected to other systems:

- Water supply
- Power supply
- Communication network
- Others life safety system
 - Detection system
 - Ventilation system
 - Emergency signaling / PA
- Operational functions
 - Operator
 - Emergency services



“ Important to recognise the weakest link in the chain”

High-pressure water mist systems – Operational reliability guidance

- Special attention to operators/protocols/HMIs



High-pressure water mist systems – Operational reliability guidance



“Operator (driver) has everything in control”

High-pressure water mist systems – Operational reliability guidance

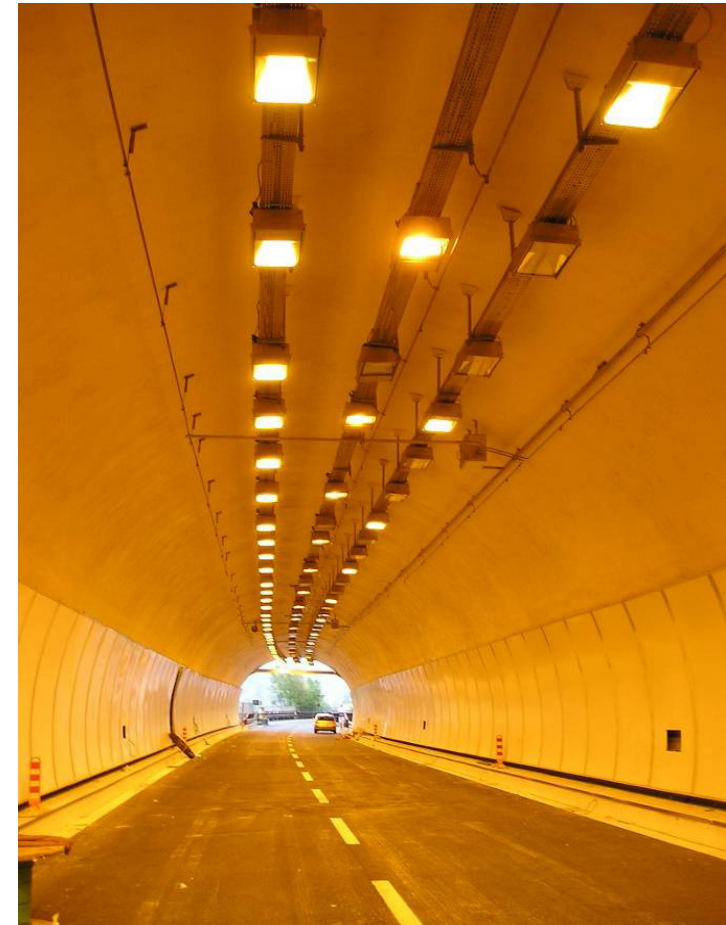


“Operator has everything in control, but...”

Long term experiences – Virgolo Tunnel

High-pressure water mist systems - Experiences

- Virgolo tunnel
 - 2 x 900m tunnels on Autostada Brennero
 - One of the main south-north routes through the Alps, 20 000 vehicles per day (30% trucks)
 - Height 6,5m and width 9,8m
- High-pressure water mist system:
 - Installed 2005-2006
 - Pumps directly driven with diesel motors
 - Stainless steel pipe work (trace heating for wet pipes)
 - Section valves with remote testing function



High-pressure water mist systems - Experiences



High-pressure water mist systems - Experiences



High-pressure water mist systems - Experiences

- Soon 10 years for pipe work inside tunnel :
 - No corrosion (AISI316Ti)
 - Pipes welded, no maintenance needed
- Pump units:
 - Tested regularly with other tunnel equipment, yearly maintenance by local contractor
 - Easy access as outside tunnel
- Section valves:
 - Can be tested remotely by SCADA from tunnel control room
- Nozzles
 - No maintenance needed (passive, teflon caps in orifices)

High-pressure water mist systems - Experiences

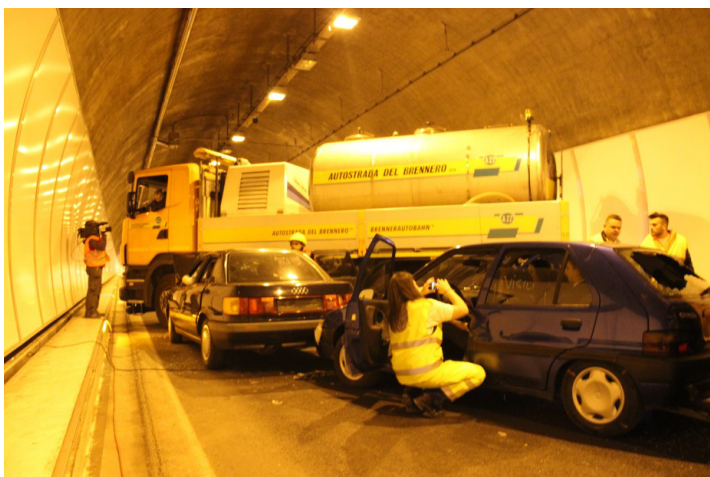
- Lessons learned:
 - Pipe material (including fixings and couplings) are very essential when looking for life cycle costs. Any problems with pipes (e.g. damages by vehicles) can cause repairs/service that are costly and limit the availability of tunnel.
 - Section valves with remote service function can lower significantly the LCCs as service personnel is not needed inside tunnel.
 - Service costs of diesel driven pump station have been much lower than expected.

High-pressure water mist systems - Experiences

- Very large scale emergency exercise was organised in October 2010 by the operator
 - Over 200 people participated to the emergency training
 - Another 200 witnessed the event
 - The objective was to test whole emergency response system with major accident(s)
 - Also high-pressure water mist system was activated as part of fire fighting methods



High-pressure water mist systems - Experiences





Conclusions

High-pressure water mist systems - Conclusions

- High-pressure water mist systems have been developed as part of European fire research projects
- They offer very good efficiency for fire fighting and costs
- Standards have changed e.g. design fires and promoting use of fixed fire fighting systems
- Often only performance (fire tests) reliability is discussed but very little attention is paid on the operation reliability
- High-pressure water mist technology has advanced significantly and it can be operated reliable and safe way
- There are some older installations like Virgolo tunnels that have shown positive long term experiences of using high-pressure water mist in tunnels