Efficient and Modern Waterbased Fire Protection of Tunnels and Transportation Applications

TUNPROTEC®

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Contents

TUNPROTEC® is an innovative low pressure water mist based fire protection system designed to minimize installation and maintenance costs, while ensuring fast and reliable protection of people and tunnel structures from fires.

TUNPROTEC® developed by VID Fire-Kill

The TUNPROTEC® system has been developed, tested and manufactured by VID Fire-Kill ApS, located in Svendborg, Denmark. Known for its highly reliable and effective products, VID Fire-Kill utilizes many years of low-pressure water mist fire protection experience to develop new and groundbreaking means of protecting buildings, tunnels and lives from fires – a unique foundation for creating the perfect fire protective solution for your needs.

All our products are developed and manufactured in VID Fire-Kill's ISO 9001 Quality Approved facilities. Our products are unique, offering better performance, better approval, or a better solution than what is on the market today.

Low pressure water mist technology

The definition of water mist as utilized by TUNPROTEC® is defined as a unique mix of small droplet sizes compliant with CEN/TS 14972 (dv.0.90), meaning that 90% of all water must be distributed in droplets less than 1000 microns = 1 mm. The small droplet sizes and the high velocity when distributed out of the nozzle orifices allow the TUNPROTEC® system to effectively control and suppress tunnel fires with a typical 80% reduction in water consumption compared to e.g. a Deluge system and with substantially lower power-/pressure requirements compared to e.g. high-pressure water mist systems.

Combining the Best of Two Technologies

Deluge → ← **High Pressure Water Mist**

↓

Low Pressure Water Mist Technology Utilizing

- Robustness and low maintenance needs from the deluge/sprinkler technology
- Low power consumption and water pressure from the deluge/sprinkler technology
- Cost efficient = utilizing PN 16 components from the deluge/sprinkler technology
- Low water consumption from the high-pressure water mist technology

How does water mist fight a fire?

Through the spread of the small sized droplets, the water mist system covers the entirety of the fire-zone and;

- Wetting surfaces and hindering material in the vicinity of the developing fire from initiating the pyrolysis process.
- By limiting the development of pyrolysis gasses, the water mist isolates the fire from its fuel source, hindering it from spreading without spending additional energy.

NB. Isolating fires from fuels, is the method most commonly used by conventional sprinkler systems, however the small droplets from low pressure water mist systems do not just stop at limiting the development of pyrolysis gasses.

Due to the small droplet sizes produced by the water mist;

- The total absorption surface volume increases with a factor 1700 due to the small droplets distributed.
- Absorbing more energy from the fire in the form of heat. This increased heat absorption minimizes the fires ability to compromise the tunnel structure and decreases the speed of which the fire can spread.

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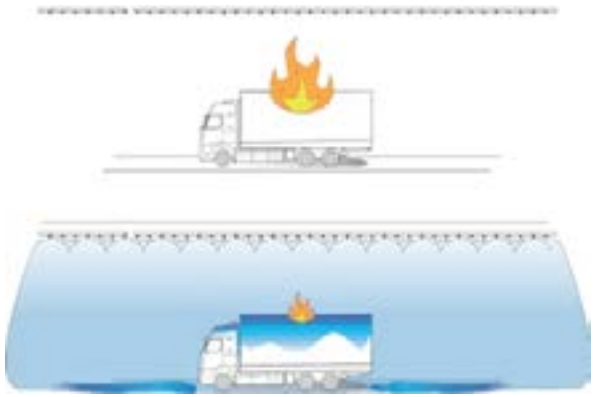

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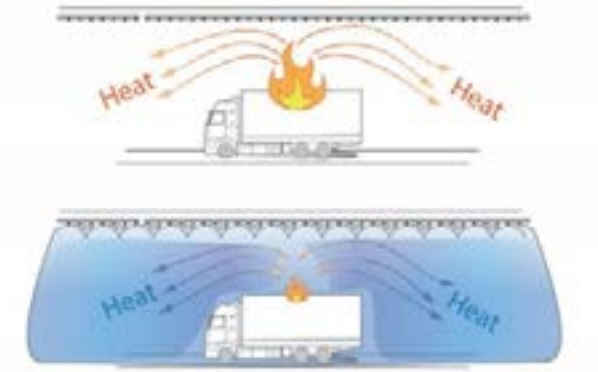

Once the small droplets have absorbed sufficient energy from the fire, the droplets will proceed to evaporate;

- As the volume of water increases as it moves from a liquid to gaseous state
- The resulting inert water vapor will displace more of the present oxygen and combustible pyrolysis gasses away from the fire
- Effectively starving and suffocating the fire and drastically limiting its ability to develop additional energy in the form of heat.

A common concern, when protecting tunnels is the development of back layering = smoke travels upstream through the tunnels forced ventilation.

- This back-layering effect limits visibility and in turn hinders rescue-/fire-fighting personnel from entering and securing the tunnel due to their personal safety.

TUNPROTEC® support and supply for different ventilation strategies, actively hinders back layering from developing.

- N-pipe version 3MS (9.8 ft/sec) solution allows for lower forced ventilation velocities (≤ 3.5 m/s, 11.5 ft/sec) within the tunnel during activation.
- Alternative developed N-pipe solutions allows for ventilation velocities higher than (≥3.5 m/s, 11.5 ft/sec).
- The resulting environment allows rescue-/firefighting personnel to safely enter the tunnel, remove casualties and actively fight the fire from short distances.

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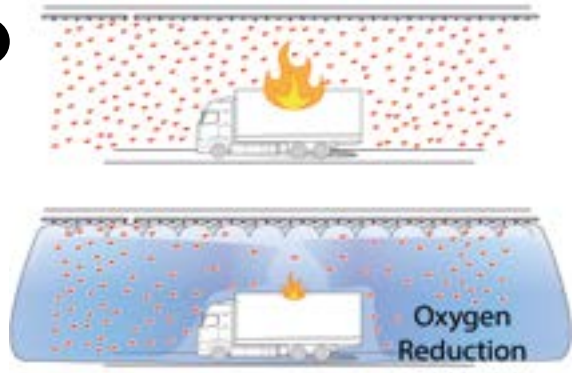

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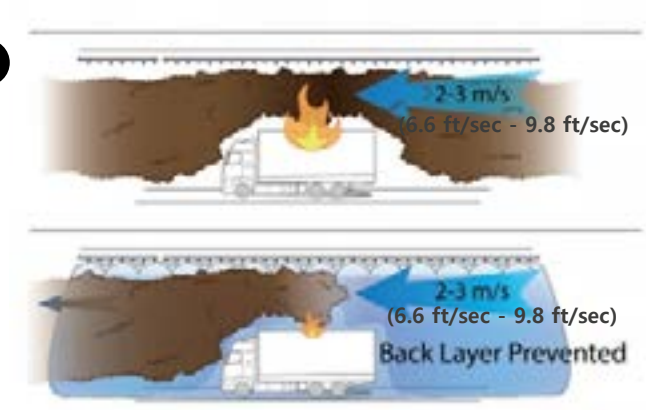


Catastrophic tunnel fires		
Fire cause	Location	Loss/damage
A HGV (truck) with flour and margarine caught fire	Montblanc Tunnel Italy/France	• 41 people died • €350 - 450 mio + €500 mio in tunnel downtime
A HGV (truck) crash caught fire	Gotthard Tunnel Switzerland	• 11 people died • €6 mio in repair costs
Fire in a chemical hauling HGV (truck)	Euro Tunnel UK/France	• €60 mio in repair costs • €200 mio income losses

Table: From scientific article from the "International Symposium on Catastrophic Tunnel Fires" (CTF), Borås, Sweden 2003.

Why install a fixed fire fighting system?

As history has shown, fires in tunnels can quickly evolve to produce devastating consequences, as tunnels often feature valuable structures, large amounts of transported hazard goods, people and limited means of accessibility and evacuation.
Tunnel fires can be very costly not only because of the repair work but also because of the business interruption it can create and not least the loss of life.
Due to the disastrous fires mentioned in the shown table, the European Commission created the work group UPTUN 251 which published guidelines and suggestions how to improve safety in existing tunnels. Also, PIARCH and NFPA have issued publications/guidelines regarding safety and fixed fire fighting systems in tunnels. Those guidelines suggest that installing a fixed fire fighting system will improve the safety level and, in many cases, they can act as guidance for tunnel consultants when planning or upgrading tunnels.

The effect of a fixed fire fighting system

No fixed fire fighting system installed

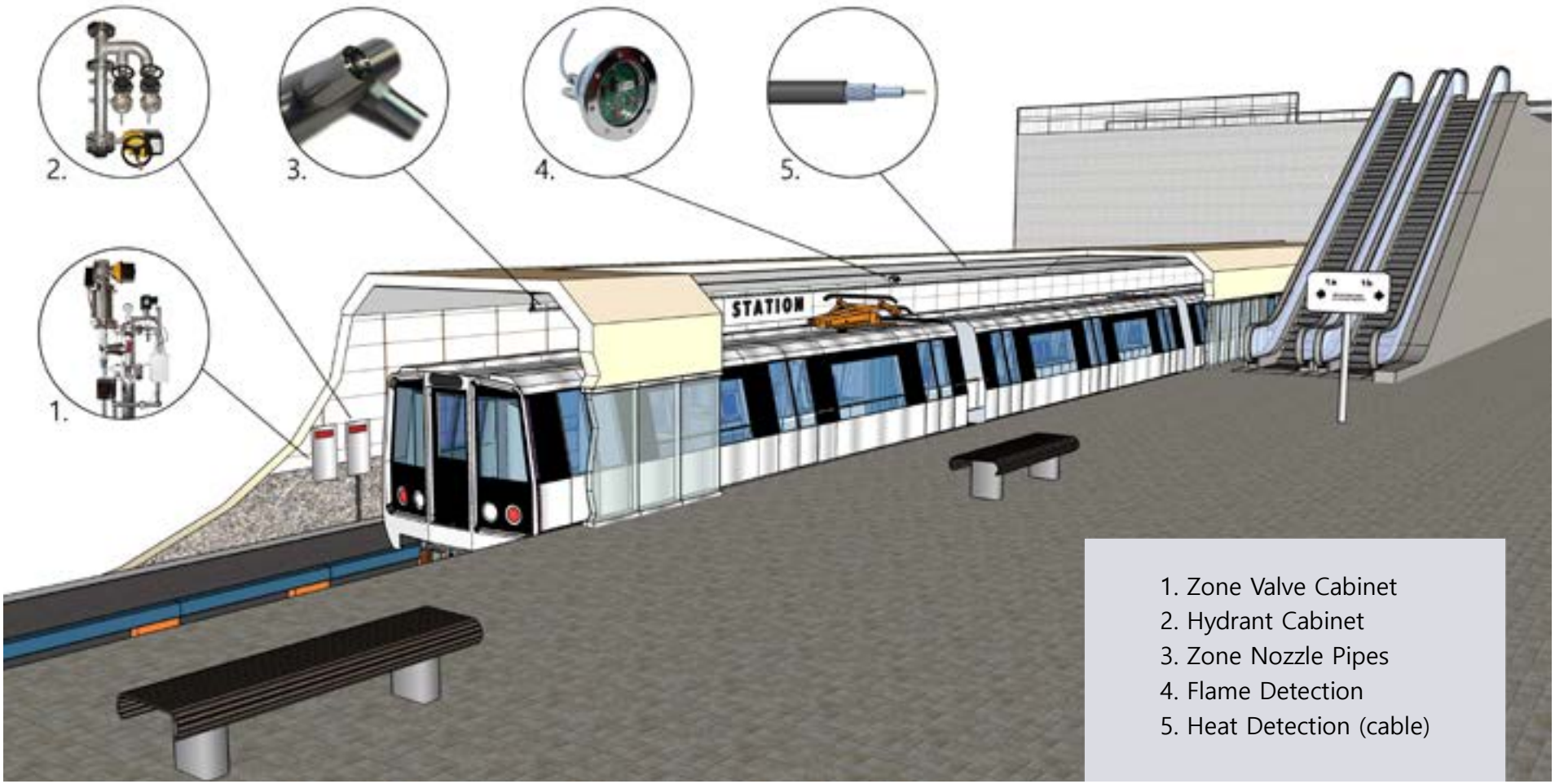
With a fixed fire fighting system installed

Two examples of major tunnel fires and their impact on the tunnels and society

- The 2007 Burnley Tunnel fire was initiated by a semi-trailer that had stopped in the left-hand lane due to a blown tire. The accident occurred when a truck ran into cars trying to drive around the stationary truck, setting off collisions between 3 HGVs and 4 cars. One of the trucks burst into flames on impact causing a large fire and explosions. Because of the installed Fixed Fire Fighting System and quick activation, the fire was quickly taken under control and suppressed - despite its high HRR output potential. Due to the effectiveness of the Fixed Fire Fighting System the tunnel and road structure was undamaged. After thorough cleaning the tunnel was re-opened 3 days after the fire.
- The 1999 Mont Blanc Tunnel fire erupted when a truck carrying flour and margarine caught on fire halfway through the tunnel. The blaze spread to the load of the flammable margarine then to 35 nearby HGVs and cars. There was no Fixed Fire Fighting System installed and the available fire extinguishers were not able to extinguish/suppress the fire in its initial stage and the temperature rapidly developed to 1000° C which made it impossible for the rescue team to enter the tunnel. The fire caused a high number of fatalities, severe structural damage and closure of an important European infrastructure line as well as an economic impact in the countries affected. The tunnel underwent a major 3-year renovation after the fire.

The TUNPROTEC® Solution (road)

The TUNPROTEC® Solution (metro/train)



The TUNPROTEC® Solution (design & function)

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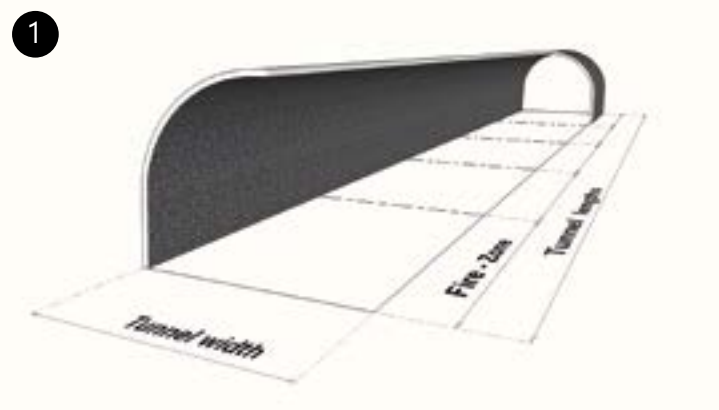

The TUNPROTEC® solution works as a zoned deluge system where the entire tunnel is divided into fire-zones.

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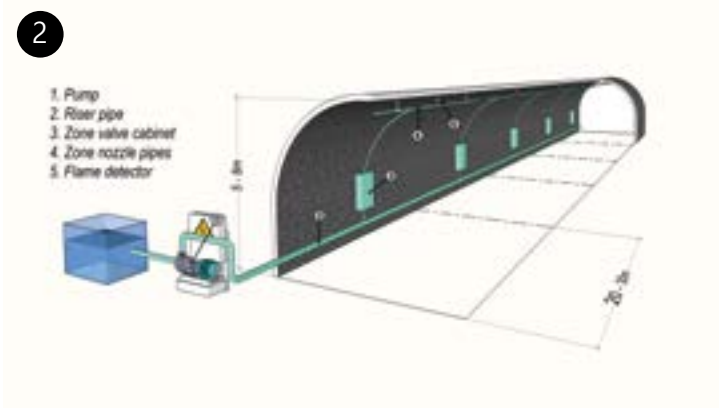

Each fire-zone can typically be 20 - 30 m (65.6 - 98.4 ft) long and up to 8 m (26.2 ft) high. One central installed nozzle line can protect up to a 12 m (39.4 ft) tunnel width. If wider, an additional nozzle line must be installed.

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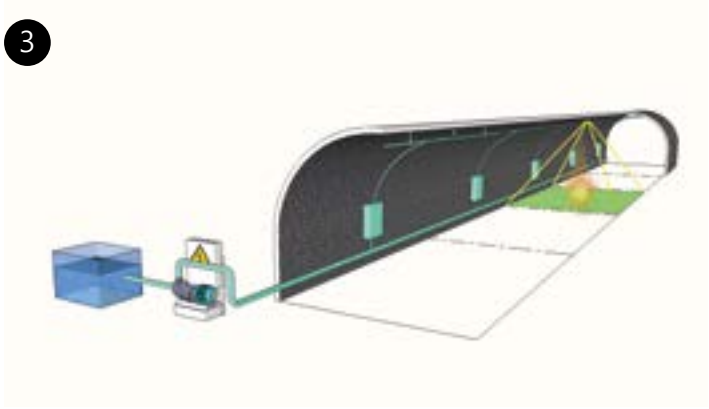

When a fire is detected in a fire-zone, the detection system sends a signal to the TUNPROTEC® Zone Valve Control Panel.

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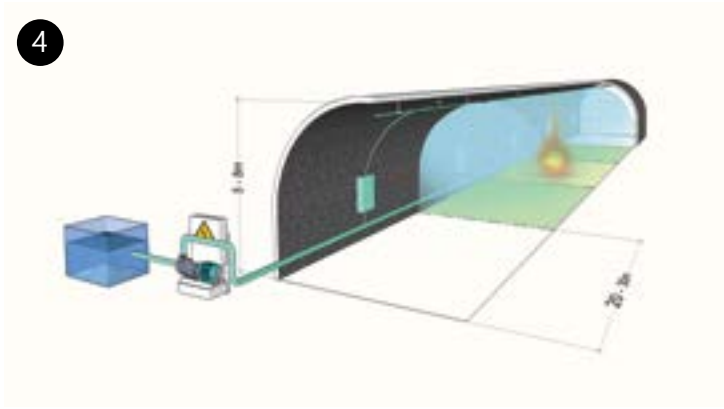


The Zone Valve Control Panel activates the TUNPROTEC® segment within the fire-zone and 2 adjacent fire-zones, while signalling the Interface Panel to alarm any connected alarm systems. By activating the adjacent fire-zones, the TUNPROTEC® system effectively suppresses and isolates the fire, preventing it from spreading.

Comparison to other technologies

TECHNICAL COMPARISON: Deluge - High Pressure - Low Pressure Water Mist			
	Sprinkler deluge	High pressure water mist	Low pressure water mist
Acceptance & tests TUNPROTEC®			• Runehamar (RISE) 30 - 100 MW full scale tunnel fire tests • San Pedro de Anes (Efectis) 250 MW full scale tunnel fire tests
Water consumption density	10.2 - 25 lpm/m² (2.7 - 6.6 gpm/ft²)	2.5 - 4.7 lpm/m² (0.7 - 1.25 gpm/ft²)	2.2 - 5.0 lpm/m² (0.6 - 1.32 gpm/ft²)
Nominal zone water flow l/m² (25 m x 12 - 18 m, 82 ft x 39 - 60 ft)	3060 - 9180 lpm/m² (808 - 2425 gpm/ft²)	675 - 1410 lpm/m² (178 - 372 gpm/ft²)	660 - 1300 lpm/m² (174 - 343 gpm/ft²)
Water reservoir for 1 hour with 3 zones active (75 m, 246 ft tunnel protection)	550 - 1450 m³ (19250 - 50750 ft³)	122 - 250 m³ (4270 - 8750 ft³)	119 - 235 m³ (4165 - 8225 ft³)
Water pressure nozzles and at pumps	Nozzles: 1.1 - 2.5 bar (15.9 - 36.2 PSI) Pumps: 6 - 8 bar (87 - 116 PSI)	Nozzles: 35 - 80 bar (507 - 1160 PSI) Pumps: 64 - 140 bar (928 - 240 PSI)	Nozzles: 10 bar (145 PSI) Pumps: 15 bar (217 PSI)
Riser pipe in 2 km (1.2427 mi) tunnel	250 - 600 mm pipe (10" - 24")	89 – 168 mm pipe (3" - 7")	125 - 150 mm pipe (5" - 6")
Power need for pump	132 - 250 KW	510 - 1080 KW	78 - 112 KW
Share riser pipe water supply with hydrants	Yes (optional)	No	Yes (optional)
Share fire waterpumps with hydrants	Yes (optional	No	Yes (optional)

Tests and approvals

Full scale tunnel fire testing in Runehamer test tunnel, Norway

Full scale tunnel fire testing at APPLUS test center in San Pero de Anes, Spain

The TUNPROTEC® system has successfully been tested for class A and B fires:

- Runehamar test (RISE) full scale tunnel fire testing 30 - 100 MW
- San Pedro de Anes (Efectis) full scale tunnel fire testing 250 MW

TUNPROTEC® components hold the following approvals:

- MSC circ. 1165 water mist nozzle component test approval
- Detection and control system EN54 approval

NB. Upon request available with SIL2 approval.

TUNPROTEC® compliant with NFPA 502 and UpTun 251 guidelines.

Compensating effects or potentials of installing a fixed fire fighting system

Fixed fire fighting systems are known to significantly reduce the fire heat release rate (HRR) from a tunnel fire. Less known are the compensatory effects of installing a fixed fire fighting system or how to exploit the full potential of the system.
The most important compensatory effects are highlighted below.

Ventilation and Critical Velocity

Thanks to the significant smoke reduction and cooling of smokes after activating the fixed fire fighting system:

- The number or capacity of jet fans can be substantially reduced.
- In certain cases, longitudinal ventilation can be used instead of planned semi-transversal, transversal ventilation systems or smoke extraction systems.

Structural Protection

Due to the excellent cooling effect of the fixed fire fighting system and its ability to absorb heat from a tunnel fire makes it possible to:

- Eliminate or reduce planned passive fire protection.
- Allow for lower fire rated components within the tunnel e.g. electrical installations.

Improved Risk Analysis

Installing a fixed fire fighting system allows for more sound strategies e.g.:

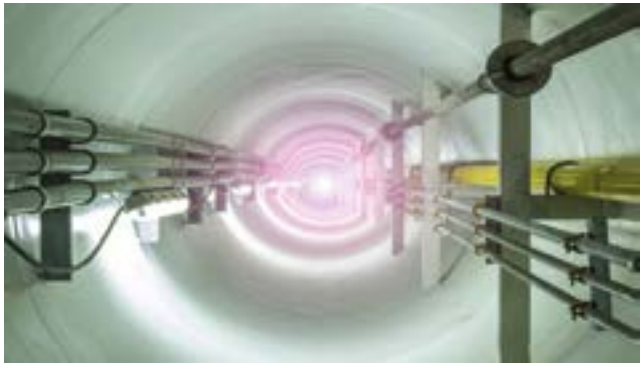
- Higher traffic intensity.
- Transport of hazardous and potentially flammable cargo through the tunnel.
- Implementation of safer evacuation strategies.

Overview of potential available compensatory effects:

- Increased level of life safety
- Quicker and easier access for rescue-/fire service
- Protection of the tunnel structure
- Lower life cycle costs
- Quick re-opening after a fire
- Reduction of insurance costs
- Avoiding or minimizing passive fire protection
- Significant smaller ventilation system

NB: The compensation effect makes it possible to balance the investment of a fixed firefighting system by recognizing the compensation effects in the total ROI

Application areas for TUNPROTEC®



Cable tunnels

Metro tunnels

Stations

Mining tunnels

Road tunnels

Train tunnels

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