

# Fire protection of tunnels

*Fires inside long tunnels are rare but can be catastrophic. Intervention by the fire brigade is difficult due to access problems. Heat and smoke make fire-fighting operations dangerous and slow. Tunnel fires pose not only a life safety threat for car or train passengers, but also cause severe damage to the tunnel lining and mechanical and electrical systems. There is special concern about fires involving heavy goods vehicles, as it seems that the most disastrous real fires in tunnels, with the highest death rates, often start at or involve a truck.*

*The HI-FOG water mist system is the optimum choice for the fire protection of tunnels. It provides powerful fire suppression using a minimal amount of clean water. The system is equipped with small piping, which is easy and fast to install.*

## General

It is not surprising that up to now only a few active fire protection systems have been installed in tunnels for practical reasons. Tunnel conditions are always windy, either due to forced or natural ventilation, and wind speeds of up to five metres / second are typical. Tests and modelling has shown that hot smoke is immediately blown away from the actual fire location so until recently activation by heat detection has not been considered reliable. Computer studies with conventional low pressure sprinklers have shown that so many sprinklers are activated by a large fire that the size of piping and pump unit would be completely impractical.

However recent full-scale tests have shown that high-pressure water mist, due to its strong momentum, can effectively penetrate the windy and turbulent conditions encountered in tunnels, and reduce temperatures sufficient to stop fire spread and structural damage.

The fire protection objective is therefore to suppress any fire that may occur, stop the fire spreading to adjacent vehicles or carriages, and minimise damage to the tunnel and infrastructure. In addition the system should cool down the gases so as to make more tenable conditions for evacuation and access by fire brigades.

## HI-FOG solution – features and benefits

The HI-FOG open spray head solution is designed as a zoned deluge system relying on a separate state-of-the-art detection system (i.e. linear heat detector and CCTV cameras) to set off the whole zone of spray heads. In some applications Marioff

recommends that the system incorporates a water mist curtain in each zone to cool down gases, restrict the spread of heat and improve the conditions downwind of the fire. This solution is simple but does require a separate, reliable detection system.

The HI-FOG automatic sprinkler solution is also divided into zones and incorporates sprinklers fitted with special protection caps, which prevent false activation. Each zone incorporates a mist screen, which is set off by a sensitive bulb-activated pilot valve and/or a separate detection system. This simultaneously blows the protection caps off the sprinklers so they are ready to operate. If the zone is a false one, the mist curtain cools down the gases and the sprinklers do not open. The system ensures that only the zones closest to the actual fire will be pre-activated. The end result is that a few curtains are spraying water, but sprinklers only within the correct zone open. The benefit of this system is that less water is used and the system has the back-up security of self-actuation.



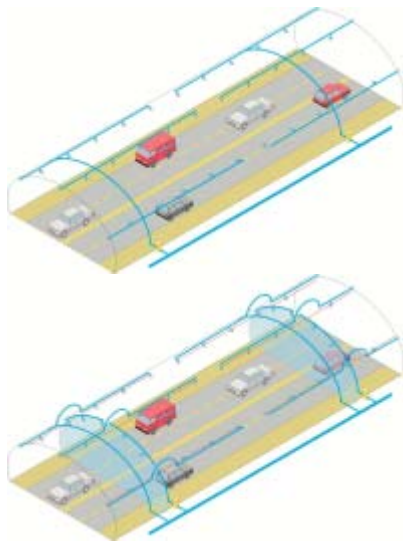
### HI-FOG BENEFITS

- Superior fire suppression
- Minimal water usage
- Easy installation with small pipes
- Safe for people and property

## HI-FOG systems

A pre-engineered HI-FOG system for protecting tunnels will consist of spray heads and/or automatic sprinklers arranged in zones down the tunnel. These are connected by small bore stainless steel tubing to the necessary valve & control units. In the case of the open spray head system these interface with the detection system. An electrically driven HI-FOG pump unit (SPU), dimensioned for one full zone of sprinklers with water mist screens or minimum of two zones of spray heads, is located at the end of the tunnel. In case of difficulties of reliable electrical supply these can be diesel-driven units.

For the HI-FOG automatic sprinkler system the choice of sprinkler bulb rating depends on the ambient temperatures, wind speeds, tunnel height and the type and number of vehicles driving in the tunnel.



## References

So far, two major full-scale tunnel fire tests programs have been completed. The first was carried out in 1999 in the UK to develop design criteria for an on-board HI-FOG water mist system in a heavy goods vehicle in a railway tunnel. The second program was carried out in June 2002 in Norway to establish water application rates required to suppress and control a fire in a full-size road tunnel. At the same time, the HI-FOG concept of zones and screens as well as the operation of the new components was successfully tested. Recent fire tests in 2004 in the tunnel have proven water mist system could effectively suppress and control fires up to 30 MW or even more.

Marioff has supplied many hundreds of HI-FOG systems protecting a number of different risks around the world. One example are the car parking tunnel and underground experiment area of Gran Sasso National Laboratory in central Italy.



Paraffin oil tanks in one of the main underground experiment halls of the Gran Sasso National Laboratory in central Italy

### Tunnel protection - HI-FOG pre-engineered water mist systems

#### Features

High pressure mist technology

HI-FOG mist screen

Special protection caps for sprinklers

Practical sized pump units & stainless steel tubes

Only water – no additives

#### Benefits

Efficient fire suppression in high ventilation conditions  
Prevents fire spreading & causing damage to tunnel & infrastructure

Ensures activation only over the fire with sprinkler system  
Cools gases ensuring safer evacuation & access by fire brigades

Prevents false activation with sprinkler system

Easy installation  
Long last components with reasonable system cost

Safe for people  
Safe for the environment

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