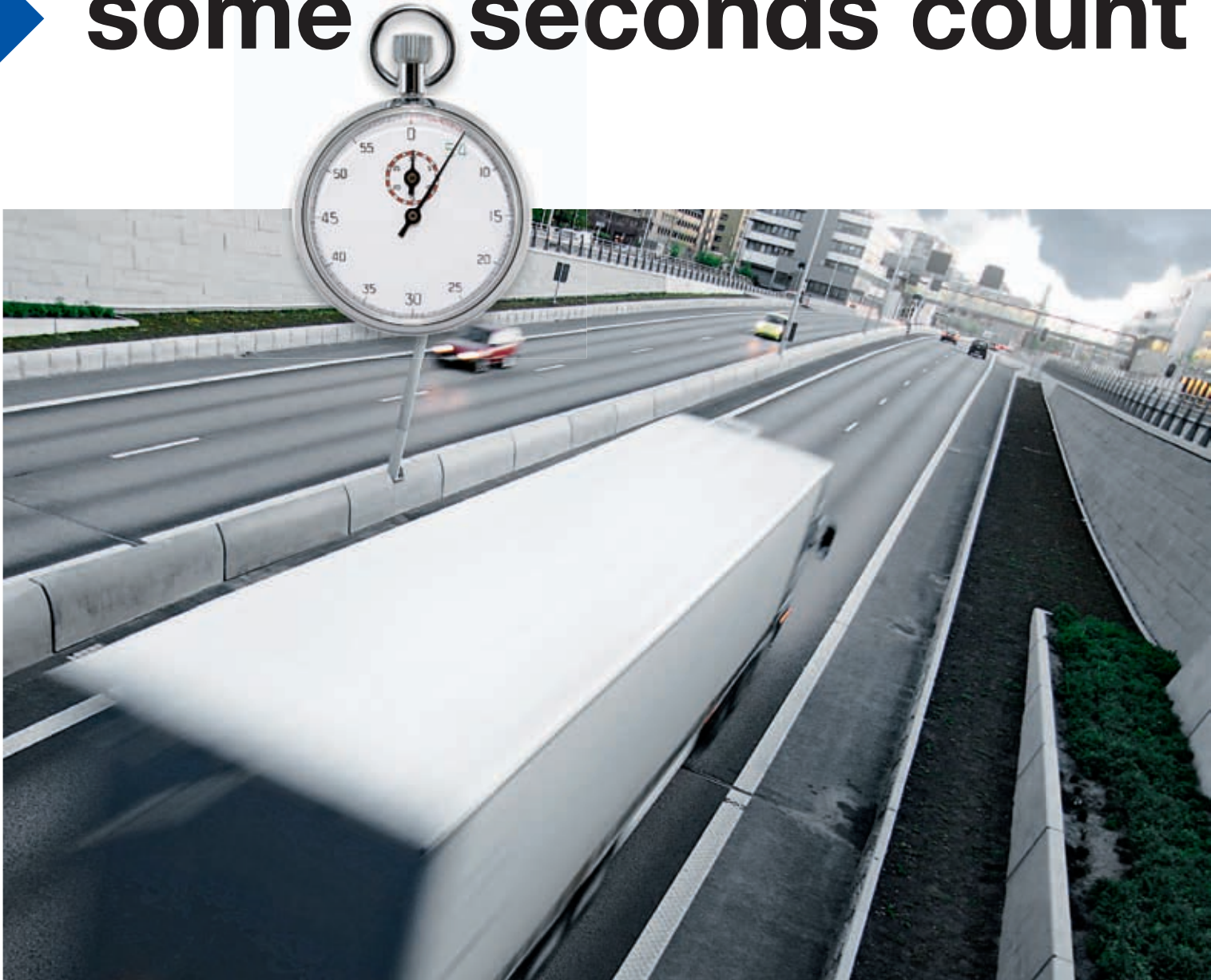


Protecting underground traffic from fire

HI-FOG[®] for road tunnels



In the fight against some seconds count



The first minutes of a tunnel fire are decisive: will it be suppressed and controlled, allowing emergency services personnel to approach and extinguish it, or will it grow out of control and spread to a catastrophic degree?

tunnel fire more than others



HI-FOG® plays the front-line fire suppression role in a typical tunnel fire fighting scenario:

- Engages the fire instantly
- Reduces the ambient temperature
- Prevents the fire from spreading
- Moderates conditions for the emergency services arriving on the scene
- Fire is extinguished



The HI-FOG® Water Mist Fire Protection System proves its value in the first seconds and minutes of a tunnel fire. HI-FOG® attacks the fire with high-velocity plumes of water mist which instantly beat the fire down, curtailing the development of its heat

intensity and cooling the surroundings very effectively. The fire is suppressed and controlled and the amount of smoke given off is greatly reduced.

Traditional deluge systems are good

Traditional deluge systems work. They suppress tunnel fires, saving lives and preventing structural damage. At Marioff we recognize that traditional deluge systems protect against tunnel fire, but we make the case that HI-FOG® is the best fire protection a tunnel can have. HI-FOG® suppresses tunnel fire more effectively than traditional deluge systems, which work primarily by wetting the fire load. HI-FOG® works in three dimensions: it instantly cools the fire itself and the surrounding air; it blocks the radiant heat; it starves the fire of oxygen.

Uses much less water and lasts longer




HI-FOG® uses substantially less water than a traditional deluge system: savings related to water supply, storage and drainage can be expected. The system's high-grade stainless steel components will substantially outlast the equivalent components of a traditional deluge system. Savings can be expected here. Furthermore, the performance and cooling capabilities of HI-FOG® may allow associated equipment to be operated at cost-saving temperatures.



Dimensioning principles

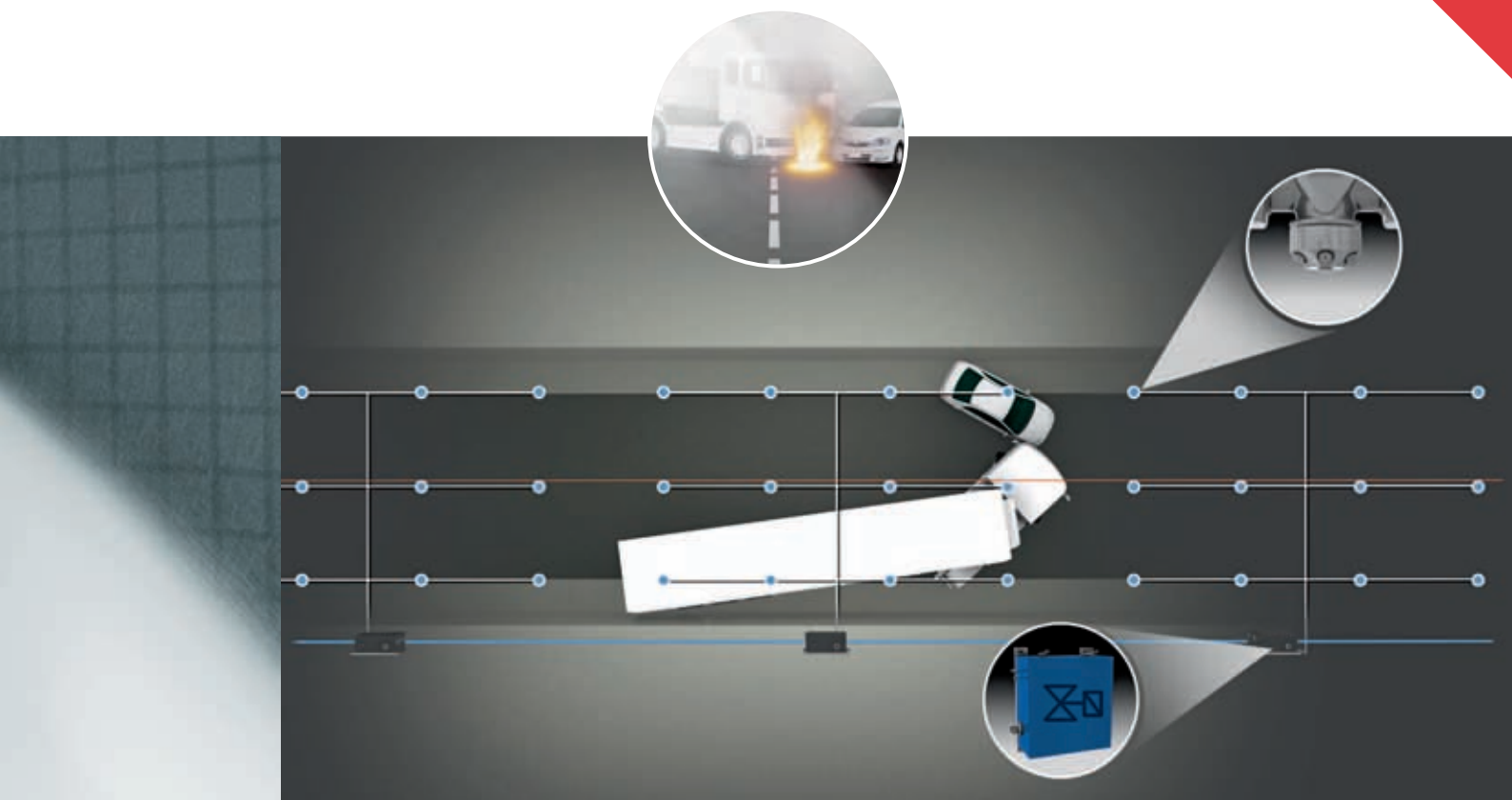
At the specification stage, HI-FOG® is similar to traditional deluge systems when it comes to dimensioning – sizing zones and deciding on the number of zones that need to be activated simultaneously. It does not introduce unwanted complexity into the equation. There is one significant

difference. With HI-FOG®, the dimensioned water flow rate is much less. Zone size is decided according to the maximum vehicle length allowed, the expected fire load, the accuracy of the fire detection system, the ventilation technique and the safety margins associated with each of these parameters.

	Typical drop size range (mm)	Number of droplets per litre of water	Surface area (m ²)
 Conventional sprinkler / water spray	1...5	15 thousand to 2 million	1...6
 Low-pressure water mist	0.2...1	2 million to 250 million	6...30
 HI-FOG®	0.025...0.2	250 million to 150 billion <i>Superior cooling and local inerting</i>	30...250 <i>Superior blocking of radiant heat</i>

HI-FOG®'s effectiveness lies in the fact that it fights fire with micro-drops of water, not drops of water. HI-FOG® water mist is unparalleled in its ability to attack two of the three things that fire needs, heat and oxygen, while being harmless to people and the environment.

HI-FOG® is better



Illustrated: HI-FOG® spray head system in action

Maximum water usage, traditional deluge system

Water usage, spray head system

Water usage, hybrid system

Water usage, sprinkler system

Marioff offers three HI-FOG® systems for tunnel fire protection:

- HI-FOG® spray head system
- HI-FOG® hybrid system
- HI-FOG® sprinkler system

The HI-FOG® spray head system is the basic choice for normal tunnels. The HI-FOG® spray head system attacks fire by directing a full flow of water to the zone in which the fire is located and the two adjacent zones.

The illustration above shows an accident scenario and HI-FOG® spray head system coverage across three zones. Zone length will vary according to the fire risk assessment and tunnel conditions. In principle, all three zones are activated simultaneously. Within seconds

of activation, the temperature a few metres away from the fire drops radically.

A HI-FOG® system for tunnel fire protection comprises the following main parts:

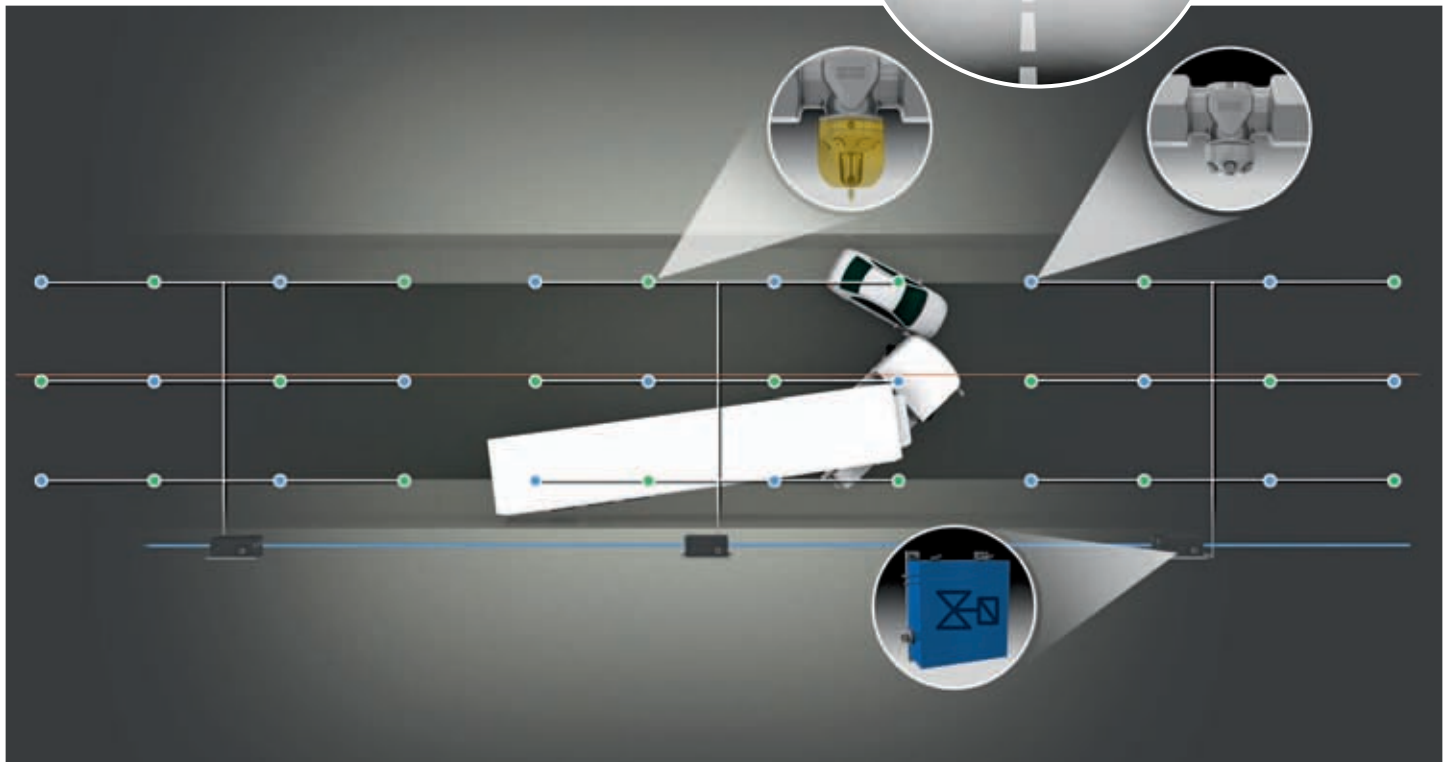
- Electric or diesel high-pressure pump units
- A water supply, fire main or tank: size depends on tunnel length, dimensions
- HI-FOG® tunnel spray heads or sprinkler heads depending on the system type
- A fire detection system conforming with requirements
- Stainless steel HI-FOG® tubing: 25 mm, 60 mm, 76 - 114 mm main tubes
- Section valves

HI-FOG[®] hybrid system

The HI-FOG[®] hybrid system is the choice for tunnels with wider than average sections and a limited water supply. The HI-FOG[®] hybrid system provides flexibility in covering e.g. areas with multiple lanes merging and emergency areas. It consumes less water overall than the HI-FOG[®] spray head system.

The HI-FOG[®] hybrid system is equipped with both HI-FOG[®] spray heads and HI-FOG[®] sprinkler heads, distributed in a mixed pattern over the zones of coverage. The HI-FOG[®] spray heads activate across the three zones relevant to the fire,

triggered by the fire detection system, preventing the fire from spreading. The HI-FOG[®] sprinkler heads attack the fire in its precise location, activating when the ambient temperature bursts their heat-sensitive bulbs. The net result is effective fire suppression with reduced overall water consumption.



HI-FOG® sprinkler system

The HI-FOG® sprinkler system is the choice for tunnels with sections that are significantly wider than average and a very limited water supply.

The guiding design principle of the HI-FOG® sprinkler system is to restrict activation

to the immediate location of the fire and thereby conserve water.

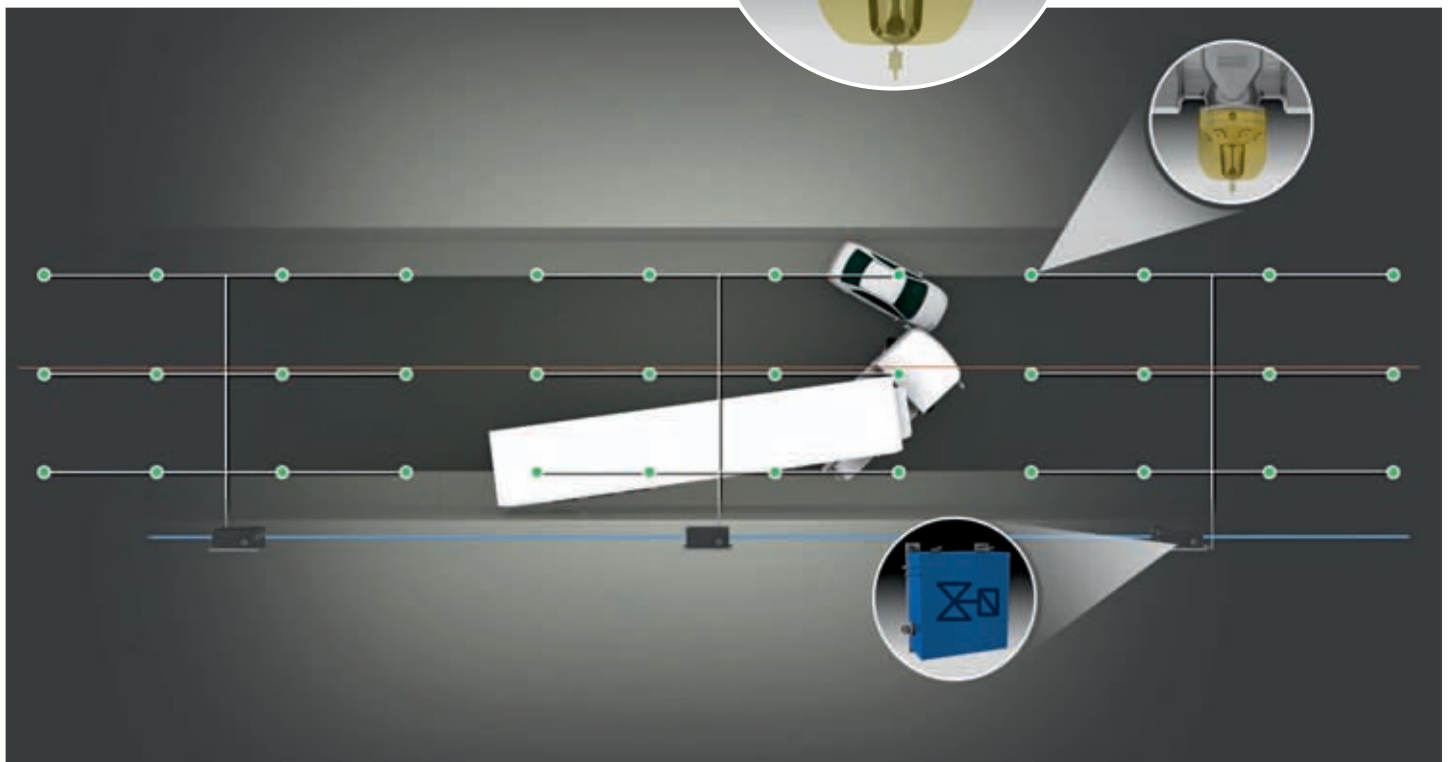
Dry pipe system

In stand-by mode, the HI-FOG® sprinkler heads are covered by a protective cap. When the fire detection system

detects a fire and pinpoints its location, pressure builds in the system and the protective caps are released from the HI-FOG® sprinkler heads, exposing the heat-sensitive bulbs. The bulbs in the immediate location of the fire burst, releasing the HI-FOG® water mist.



The HI-FOG® sprinkler head's protective cap prevents premature system activation.





Spotlight: A86 West

Protected by the world's largest



tunnel, Paris

water mist fire protection system



The A86 West tunnel in Paris, part of the new A86 super-ring road, is the first large European tunnel to be protected with an active fire protection system. This 10 km tunnel linking Rueil-Malmaison and Versailles will ease traffic flow in the West Paris region under the protection of a HI-FOG® spray head system. This system will be the largest water mist fire protection system ever built. Its stated mission is the following in case of fire:

- Reduce the ambient temperature, facilitating the evacuation of motorists to the emergency exits located at 200-metre intervals;
- Moderate conditions for the emergency services arriving on the scene, allowing them to contain, control and extinguish the fire.

The A86 HI-FOG® system carries out its mission with 24 spray heads per coverage zone, each 33 metres long. In case of fire, three zones will activate simultaneously covering an area about 100 m long around the seat of a fire.

Two of the three pumping stations will activate and distribute water mist at a nominal pressure of 70 bar at the spray heads. The system has substantial built-in redundancy to ensure fail-safe operation.

Marioff carried out a full program of fire testing for the A86 West tunnel project, testing the HI-FOG® system against the defined requirements and fulfilling them to the customer's satisfaction.



Ensuring traffic continuity



The HI-FOG® Water Mist Fire Protection System will help you keep traffic flowing safely through your tunnel by minimizing the threat posed by fire. This is a long-term proposition, and Marioff supports HI-FOG® over the complete lifecycle of the system.

Design services

Marioff will design the right HI-FOG® system for your tunnel based on the fire risk assessment and the tunnel's dimensions, water supply and any special protection requirements for associated technical and personnel areas.

Installation

Marioff is expert at installation in the tunnel environment. The full range of our experience will be placed at your disposal in the project planning stages. Marioff has the resources to carry out very large tunnel installations, keeping to the prescribed schedule and quality metrics.

Low maintenance costs, long system life

The HI-FOG® system is made of high-quality components and stainless steel tubes to ensure long system life and minimal maintenance costs.



Marioff provides a full palette of services to ensure that the HI-FOG® system stays in peak condition throughout its lifecycle.

Environmentally friendly

HI-FOG® uses very little water (potable, supplied through the regular mains) to ensure environmentally safe and responsible performance.

Training

As part of your overall safety regimen, Marioff will train your staff to operate the HI-FOG® system to make sure it performs at its best when it really matters – all the time.

The world's pre-eminent water mist company

Founded in 1985, Marioff is the world's leading provider of water mist systems for fire protection on land and at sea. About 1,000 passenger cruise ships and ferries are protected by HI-FOG® at sea. About 1,500 installations are protected by HI-FOG® on land: heritage buildings and museums, hospitals, libraries and archives, IT and telecommunications facilities, energy facilities, road tunnels, metro trains and stations, factories – the list is long and growing fast.

Relentless fire testing

With over 6,000 full-scale fire tests behind it, the HI-FOG® Water Mist Fire Protection System is the world's most tested water mist system. HI-FOG® has been tested thoroughly for tunnel fire protection and its performance in this environment is a known, impressive quantity.

Tunnel fire testing programs

Marioff conducted two major tunnel fire test programs in Norway as part of HI-FOG® system development. Tunnel-specific fire test programs have been carried out for the M30 tunnel in Madrid and the A86 West tunnel in Paris.



Full-scale tunnel fire test carried out for the M30 Madrid tunnel project.

HI-FOG® spray head for tunnels



Body assembly and protective cap



HI-FOG® sprinkler head and assembly for tunnels



Stainless-steel HI-FOG® tubes, shown actual size



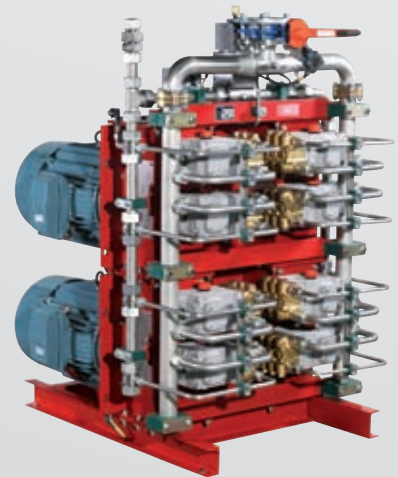
25 mm longitudinal branch tube



60 mm cross tube



SAE2 stainless steel valve cabinet, built to last in tunnels



SPU4 electric pump unit. Provides constant flow of 140 bar pressure during activation. Can be reset quickly and automatically after a discharge.



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