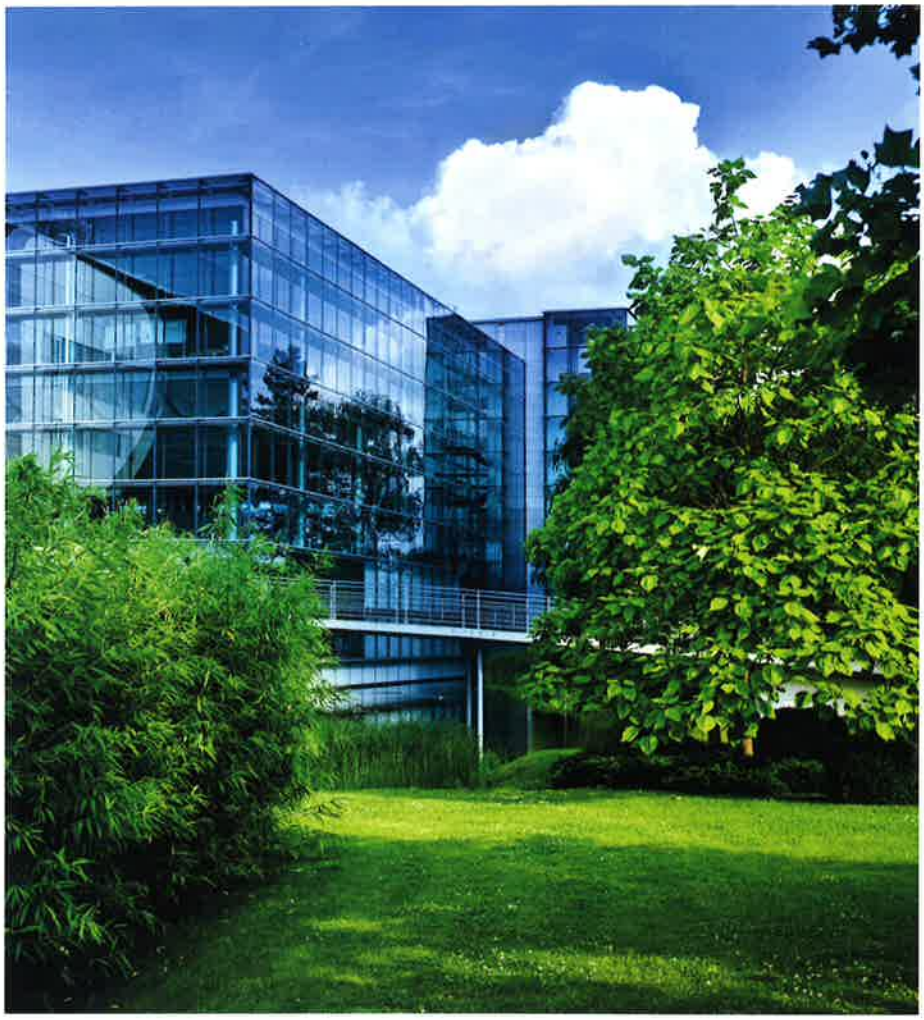
HI-FOG®
water mist fire protection

HI-FOG® for buildings

Technical introduction

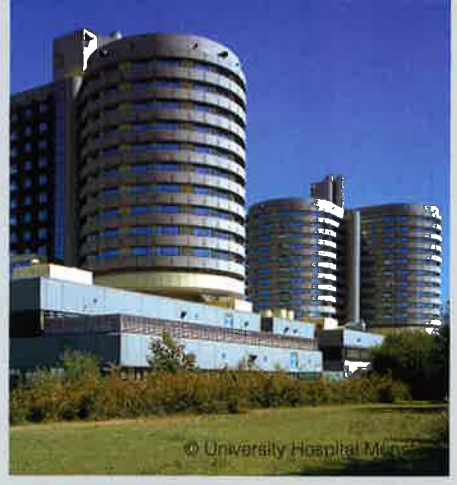






Protecting people, property and business continuity

Marioff
United Technologies











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Introduction to HI-FOG®

HI-FOG® is the trade name of the high-pressure water mist fire protection system developed and manufactured by Marioff. The HI-FOG® Water Mist Fire Protection System uses small amounts of pure water to control, suppress or extinguish fires.

Traditional sprinkler systems employ wetting as the fire fighting mechanism, and therefore require very large amounts of water. HI-FOG® uses less water than a traditional sprinkler system, while delivering equivalent or better performance for the same application.

The potential damage and risk to life posed by a fire are clear and well understood. The potential damage caused by a water-based fire fighting system, however, is often underestimated. In multi-story buildings, water leakage from a discharge in upper stories only makes the situation worse.

The exceptional performance of HI-FOG® helps ensure water use is kept to a minimum. In a controlled demonstration, one HI-FOG® nozzle discharged around 380 liters (100 gallons) of water in 30 minutes using a gas-driven pump unit. A traditional sprinkler system, in turn, discharged some 3,600 liters (951 gallons) from a single nozzle within the same time period.

Tested and approved

The fire fighting performance of any water mist system is dependent upon many factors. Therefore, any system should undergo full-scale fire testing as part of an approval process based on a commonly accepted set of performance criteria.

HI-FOG® is the result of unceasing and relentless research and development. HI-FOG® has been tested in more full-scale fire tests than any other water mist fire protection system and ranks among the most widely certified.

High-pressure water mist systems as exemplified by HI-FOG® are a major step forward in water-based fire protection. The number of application areas, test standards and performance criteria, type approvals, and market acceptance in the form of customer references are growing at an accelerating rate.

HI-FOG® can be used to fight both solid and liquid fires. There are very few fire risks which cannot be protected against. Water-based fire fighting systems cannot be used to fight liquid metal fires or to protect materials which react adversely when combined with water.

	Approval	FM LH	FM LH	FM Machinery spaces	FM Machinery spaces	FM Machinery spaces	VdS OH1	VdS OH1	VdS OH2 Parking garage	VdS OH3	VdS Machinery spaces	UL OH1
	Technology	HI-FOG®  SPU	HI-FOG®  GPU	HI-FOG  GPU	HI-FOG®  GPU	HI-FOG®  SPU	HI-FOG®  MSPU	HI-FOG®  GPU	HI-FOG®  MSPU	HI-FOG®  MSPU	HI-FOG®  GPU	HI-FOG®  SPU
	Max room height / volume	5m / unlimited	5m / unlimited	10m / 1500m³	11m / 1375m³	11m / 1375m³	4m / unlimited	4m / unlimited	3m / unlimited	5m / unlimited	5.6m / 500m³	4m / unlimited
APPLICATION	Hotels	●	●				●	●	●	●		●
APPLICATION	Data Centers	●	●	●	●	●	●	●			●	●
APPLICATION	Heritage buildings	●	●				●	●	●	●		●
APPLICATION	High rise buildings	●				●	●		●	●		●
APPLICATION	Hospitals	●	●	●	●	●	●	●	●	●	●	●
APPLICATION	Stations	●	●	●	●	●	●	●		●	●	●

How HI-FOG® fights fire



Fire is a process which involves a chemical reaction between a combustible fuel and oxygen. The four prerequisites for this process to be sustained:

- Fuel: solid (Class A), liquid (Class B) or gas-phase
- Oxygen
- Heat
- Uninterrupted chemical reaction

The size of a fire is described by its heat release rate, measured in Watts (W). A flaming fire that can be approached with a hand-held extinguisher typically has a heat release rate of under 1 Megawatt (MW). As a rule of thumb, one square metre of visible flame corresponds to 1 MW of fire. A fire is becoming serious when it reaches 5 MW.

At least one of the four prerequisites for sustained burning must be eliminated to extinguish a fire. It is rarely possible to remove the combustible fuel, but the remaining prerequisites can be affected by different fire fighting agents.

Fires can be fought manually or with the aid of fixed fire fighting systems. A fixed system's role typically consists of controlling or suppressing the fire until it is extinguished manually such that re-ignition cannot occur.

The three different fire-fighting terms used to describe the objective of a fire fighting system. These terms describe different results and should be used carefully and precisely when describing the performance of fixed fire fighting systems.

Manual intervention is always required to completely extinguish a fire when suppression and/or control systems are in used.

- **Control**
  Limitation of fire size, decrease of heat release rate and prevention of structural damage
- **Suppress**
  Sharp reduction in rate of heat release and prevention of re-growth
- **Extinguish**
  Complete suppression until there are no burning combustibles

Source: NFPA 750 standard on water mist fire protection systems, 2010 edition

Water mist as a fire fighting agent
Water is the oldest, most widely used and the most widely available fire fighting agent in the world. It has superior fire fighting capabilities over a wider range of applications compared to other available fire fighting agents while remaining non-toxic and environmentally friendly. Water fights fire with three mechanisms:

- Cooling: when water turns into vapour, it absorbs more heat than any other fire fighting agent
- Inerting: when water evaporates, its volume expands over 1,700 times, displacing oxygen locally
- Blocking: when in the form of water mist, the radiant heat is blocked

The evaporation rate of water depends on surface area: water in a bucket evaporates much more slowly than water spread out on a floor. The surface area can be greatly increased by turning water into tiny droplets, resulting in high evaporation which leads to more efficient cooling and inerting.

Therefore, a lot less water is needed by a HI-FOG® system to achieve the same performance as traditional water sprinkler systems. HI-FOG® also has the added benefit of protecting the surroundings from radiant heat.

Small droplets as such do not guarantee effective fire fighting. They need to penetrate the outward flows of flame produced by the fire. The effectiveness of a water mist system is determined by

- Droplet size
- Number of droplets
- Droplet penetration into the fire

The combination of these properties is entirely system-specific.

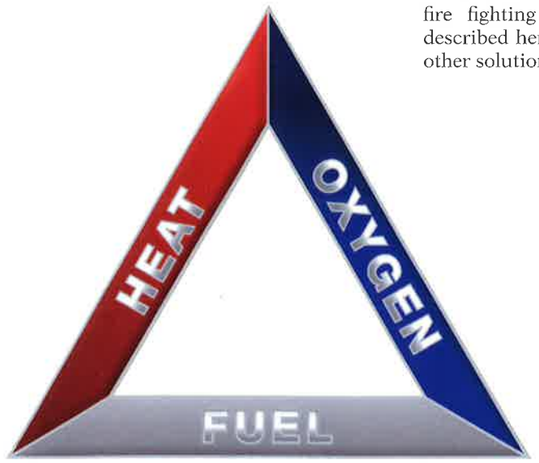
HI-FOG®'s fire fighting capabilities
All water mist systems are unique. The fire fighting capabilities of HI-FOG® described here cannot be generalised to other solutions.

A fine mist of potable water is discharged through specially designed HI-FOG® sprinkler and spray heads. The water mist is discharged at high velocity by high-pressure pumps, quickly penetrating a fire while cooling the space. It blocks the radiant heat, preventing the fire from spreading.

Depending on the application, HI-FOG® is designed to extinguish fire (typically flammable liquid fires) or suppress and control fire (solid fuel fires). HI-FOG® is a high-pressure water mist system that is powered by constant-pressure electric or diesel pumps, or by pressurized gas.

HI-FOG® water mist's range of penetration may be up to 8 m (26.3 ft) horizontally under normal conditions; even greater distances may be reached vertically. The good range of penetration means HI-FOG® water mist can spread quickly throughout a space, to some extent even past obstacles.

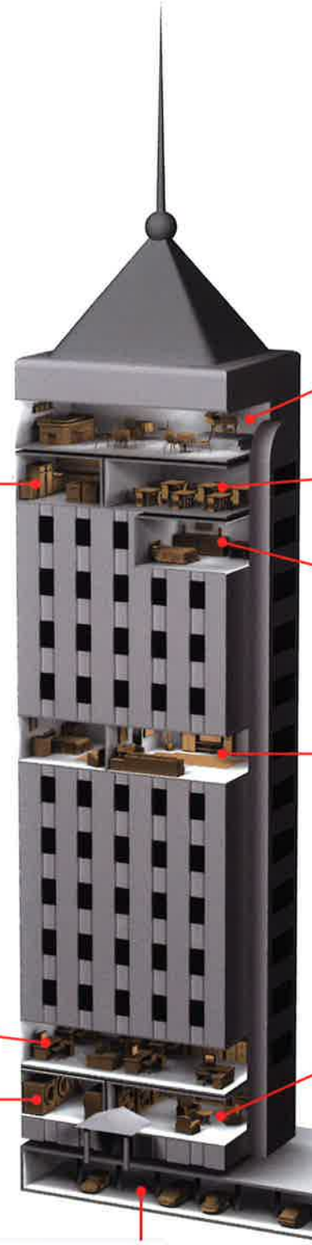
The extremely high cooling, inerting and radiant heat blocking efficiency of HI-FOG® means it is a very fast acting system. Temperatures around the fire drop abruptly within seconds after discharge. A dense cloud of water mist quickly envelopes the fire, blocking radiant heat. Structures adjacent to the fire are well protected, even when the fire is still burning.



HI-FOG® system discharges a very fine water mist as a high-pressure fog, which as such blocks radiant heat and absorbs heat efficiently through evaporation, cooling the surroundings and minimizing the collateral damage fire can cause.

Principles of HI-FOG® system design

Great performance and flexibility mean HI-FOG® can protect an entire building.



Water mist systems are designed on a performance basis. A water mist system should never be designed using one supplier's system and another supplier's test results. The complete system offering should be fully fire-tested for the given application.

Wherever possible, HI-FOG® systems are designed in accordance with Marioff's comprehensive range of approvals. In other cases they are designed on a project-by-project basis according to results from fire tests supervised and witnessed by third parties. In most cases, system designs must be approved by local fire officials or authorities.

HI-FOG® system for a building is compliant with the NFPA 750 Standard on Water Mist Fire Protection Systems when the standard is applicable.

System types

HI-FOG® offers great flexibility: different tubes, valves and nozzles can be selected depending on the application and fire risk. A HI-FOG® system can be a single configuration or a mixture of several configurations. In an office building, for example, the main configuration could be a wet pipe system with a pre-action system configuration protecting the computer server room and a deluge type system protecting back-up generators. All configurations would be fed by the same pump unit.

Wet pipe system
A wet pipe system normally has closed, heat-activated sprinkler heads. The activation bulb bursts when the ambient temperature at the sprinkler head exceeds the prescribed rating. Water mist is discharge from that particular sprinkler head.

Wet pipe systems are the most common type of system because they are the most economical for medium-size and large areas that need to be protected against normal fire hazards. They also have the benefit of only discharging at the point of detection.

Deluge system
A deluge system normally has open spray heads. The water flow is usually controlled by a closed-type valve. When a section valve is opened –manually or by a detection system – water mist is discharged from all the spray heads in the area controlled by that valve.

Deluge systems are typically used for protecting machinery spaces because they provide full, homogeneous protection throughout the space.

Dry pipe system
A dry pipe system operates in much the same way as a wet pipe system, but the valve keeps the water on the pump side of the tubing in normal operation. The tubes from the valve to the sprinklers are filled with compressed air, which is monitored.

The monitoring switch detects the loss of air pressure when a sprinkler bulb beaks and opens the section valve. Water fills the tubes to the sprinklers and water mist is discharged from the activated sprinklers.

This type of system is typically used when the protected area is subject to freezing.

Pre-action system
A pre-action system is very similar to dry pipe except that it is connected to a fire detection system. Typically, a pre-action system valve requires both a sprinkler bulb to break and an activation signal from an independent fire detection system before it opens.

This type of system usually protects areas where the risk of accidental discharge needs to be minimized. Pre-action systems are ideal for buildings such as large data centres and museums.

Hydrant
A manually operated hydrant can be connected to HI-FOG® systems using single fluid pump units.

HI-FOG® system description

A typical HI-FOG® system comprises the following:

- Water supply
- High-pressure pumps or accumulators
- Tubing network
- Section and/or machinery valves
- Sprinkler and/or spray heads

The placement of HI-FOG® sprinkler and spray heads in a building is decided according to the system design guidelines, application-specific fire tests, local fire regulations and the building's technical requirements. A control system, hydrants, panels, release devices, compressors and other equipment can be added as required.



Water supply
The water supply for HI-FOG® pump units is always kept separate from the pump units. The water supply may be a mains feed or a water tank that can be dedicated to the water mist system or shared with other systems. With some pump unit types, a water inlet pressure of 2 bar is needed, so a feed water pump is add to the inlet water.

The size of the water tank depends on the application, local requirements and the pump unit type. The size of the tank will typically be 3-9 m^3 (177-318 ft^3) for a gas-driven pump unit and 20-40 m^3 (706-1413 ft^3) for an electric pump unit.

Filters are used in all HI-FOG® pump units to ensure the quality of the water. Maintaining water quality helps ensure reliable operation and long system life.

Pump units
HI-FOG® systems for buildings typically use one of the following pump unit types: gas-driven pump unit (GPU), electric pump unit (SPU), modular electric pump unit (MSPU), or a diesel pump unit (DPU).

The GPU does not need external power for operation because it is driven by gas, using either air or nitrogen. It is typically used for low hazard areas and machinery spaces. The GPU uses very little water to fight fires and is therefore a very popular choice for heritage buildings, hotels, and large data centres.

The SPU is suitable for almost any application. It is comes in a range of sizes and configurations. For larger installations a number of SPUs can be joined together. The MSPU is a modular version of the

Pump unit type	Minimum space for pump unit including servicing space (mm / in)		
	Length	Width	Height
GPU Integrated 7+7+6W	3000 / 120	2000 / 80	2300 / 90
GPU Module	1100 / 45	900 / 35	
Cylinders 4+4	1200 / 50	1500 / 60	
Cylinders 6+6	1800 / 70		
MSPU 3	2300 / 90	2000 / 80	2200 / 90
MSPU 4	3800 / 150	2800 / 110	2000 / 80
SPU2	2500 / 100	1475 / 60	1716 / 70
SPU3			2200 / 90
SPU4		2200 / 90	
SPU5			2241 / 90
SPU6			
DPU400	2800 / 110	3600 / 140	2500 / 100



GPU



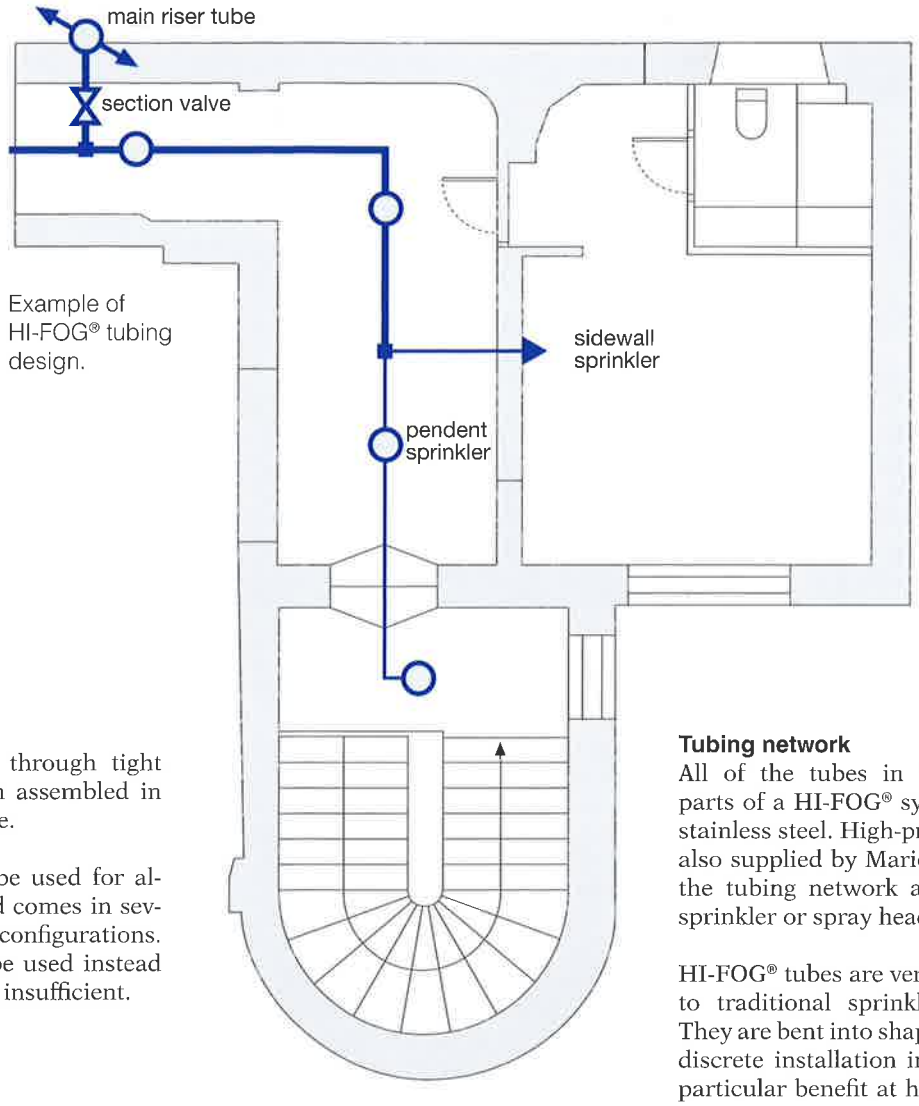
MSPU



SPU



DPU



Example of HI-FOG® tubing design.

SPU. It can be carried through tight spaces in parts and then assembled in the final installation space.

The DPU unit can also be used for almost any application and comes in several different sizes and configurations. The DPU400 will often be used instead of an SPU when power is insufficient.

Pipe diameter (mm / in)	Bending radius (mm / in)	Usage
12 / 0.5	30 / 1.2	Branch
25 / 1.0	63 / 2.5	Main distribution
30 / 1.2	75 / 3.0	Main riser
38 / 1.5	95 / 3.7	Main riser
60 / 2.4	150 / 5.9	Mega system riser

The HI-FOG® tube sizes are selected according to hydraulic calculations based on the Darcy-Weisbach calculation method as required by the NFPA 750 Standard on Water Mist Fire Protection Systems.

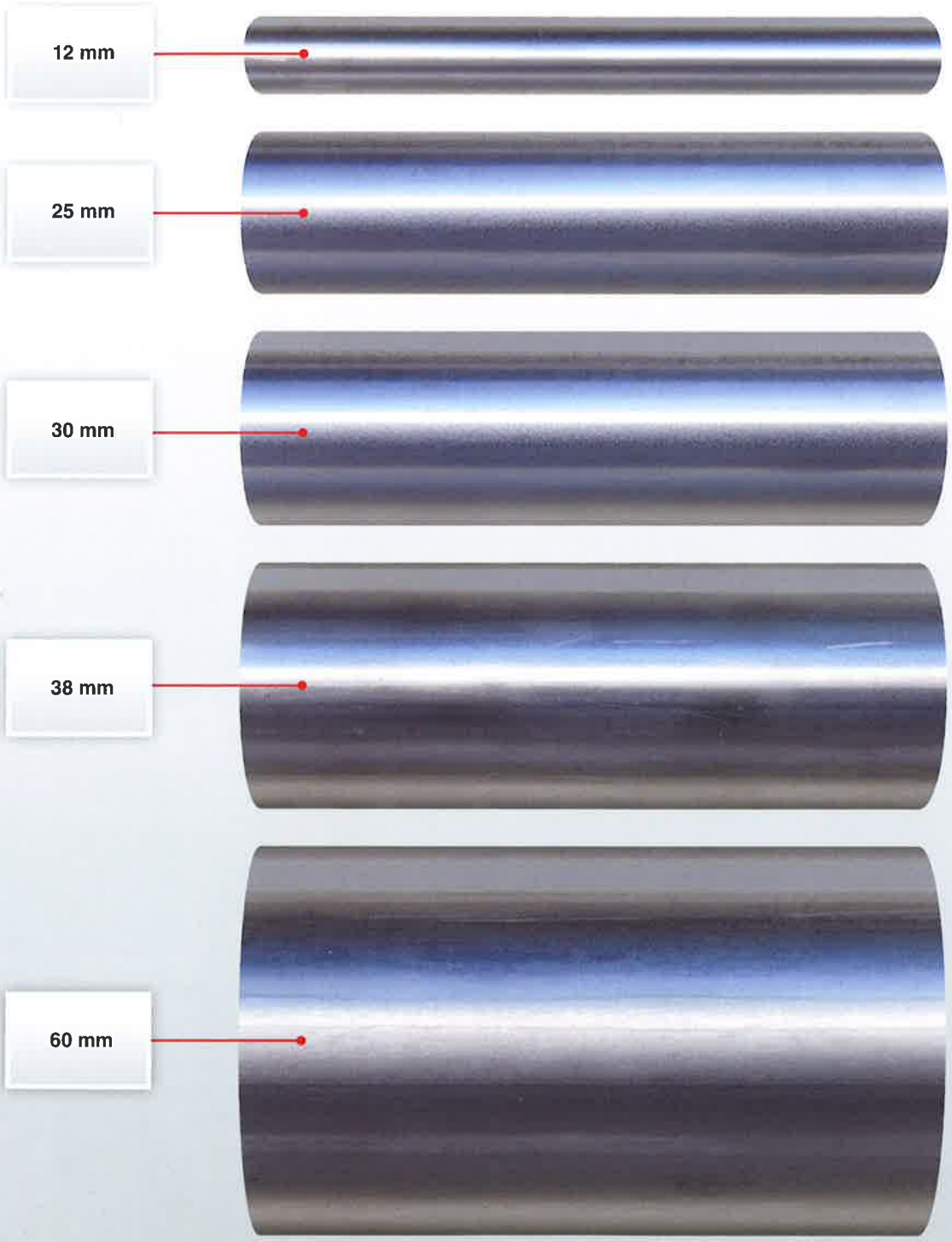
At the end of each main tubing zone a closed, manually- operated ball valve is normally installed for flushing the system as needed – especially if the system is a wet-pipe system.

Tubing network

All of the tubes in the high-pressure parts of a HI-FOG® system are made of stainless steel. High-pressure fittings are also supplied by Marioff for completing the tubing network and mounting the sprinkler or spray heads.

HI-FOG® tubes are very small compared to traditional sprinkler system pipes. They are bent into shape onsite, enabling discrete installation in tight spaces – a particular benefit at heritage sites. Connections for the high-pressure tubing are made using cutting rings for tube sizes up to 38 mm (1.5 in) in diameter; flare fittings are used for tubes larger than 38 mm (1.5 in) in diameter. All tubes and fittings are rated for high pressure and burst-tested to at least four times the maximum operating pressure. During commissioning, the high-pressure tubing is submitted to a pressure test following NFPA 750 guidelines to ensure correct and leak-free installation.

The HI-FOG® tubing network is somewhat different from traditional sprinkler piping. HI-FOG® systems are usually designed around a main supply tube from which smaller tubes branch off with their own section valve. The nozzles are fed by 12 mm (0.5 in) tubes coming off the branch tube. Typically about two-thirds of the tubing network is composed of 12 mm (0.5 in) tubing.



HI-FOG® stainless steel tubes: shown actual size

Section valves
HI-FOG® section valves can be open or closed-type valves. Open-type valves are used in wet pipe systems and closed-type for other configurations.

Section valves come in different sizes to handle different flows. They can be operated manually, electrically, and hydraulically, or combinations thereof. Section valves can also be fitted with flow indicators so that flow can be monitored.

Normally, open-type section valves for wet pipe systems are only closed to stop a discharge or to carry out maintenance. They will usually be operated manually.

Section valves are typically located outside of the protected area, either adjacent to the exit or in a central location.

Sprinkler and spray heads
HI-FOG® sprinkler heads are closed nozzles. They are equipped with heat-activated glass bulbs that hold back system pressure. HI-FOG® spray heads are open nozzles without any type of heat-activated bulbs.

A wide range of HI-FOG® sprinkler and spray heads are available, each designed for a different application and type of fire hazard according to parameters such as ambient temperature, ceiling height, ceiling/wall/floor mounting, pump unit type, ambient pollution level and so on. The selection of HI-FOG® sprinkler heads or spray heads is based on the application and the fire tests and approvals for that application.

The heat-activated HI-FOG® sprinkler heads are typically selected according to occupancy and the temperature at which activation is to occur. The temperature ratings for the bulbs are 57°C (135°F), 68°C (155°F), 79°C (175°F), 93°C (200°F) and 141°C (286°F). The sprinkler bulbs have a super-fast Response Time Index (RTI) rating of 22(ms)½.

HI-FOG® sprinkler heads have the added benefit of a unique assembly body that greatly eases maintenance. The design, patented by Marioff enables faster maintenance through the use of a local valve. Instead of emptying the tubing network, the valve can simply be close to service or replace the sprinkler head.

In addition, there are a number of application-specific HI-FOG® spray heads. These are typically used in places where air flow cannot be restricted (such as ducts and chimneys) or where there are special requirements for mounting or nozzle construction.

HI-FOG® sprinkler and spray heads can be installed in very tight spaces thanks to the small diameter of the HI-FOG® system tubing. A wide range of surface-mounted assembly bodies is available.



Patented check valve makes maintenance procedures fast and simple.



HI-FOG® 2000 -series nozzles





HI-FOG® 1000 -series nozzles

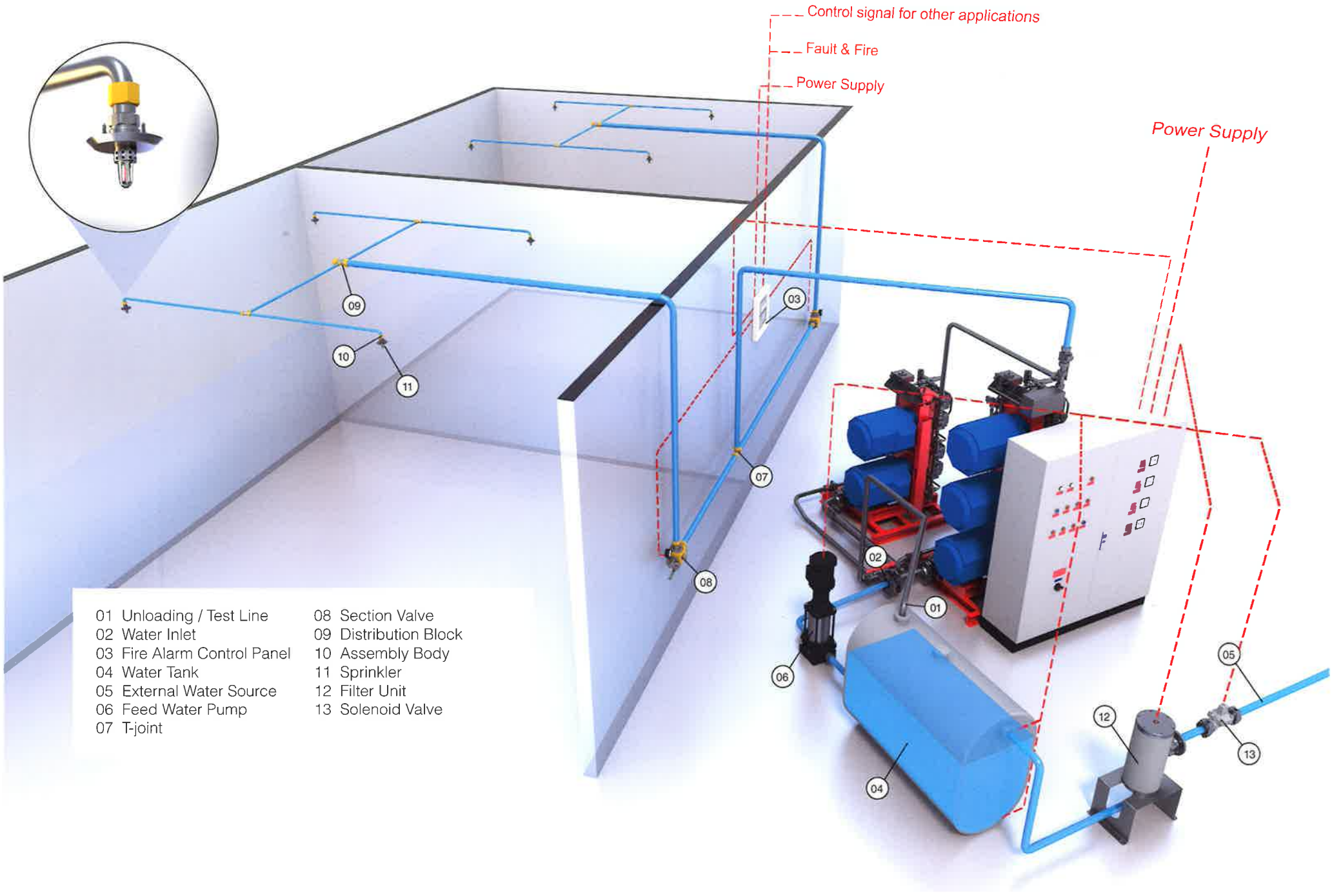


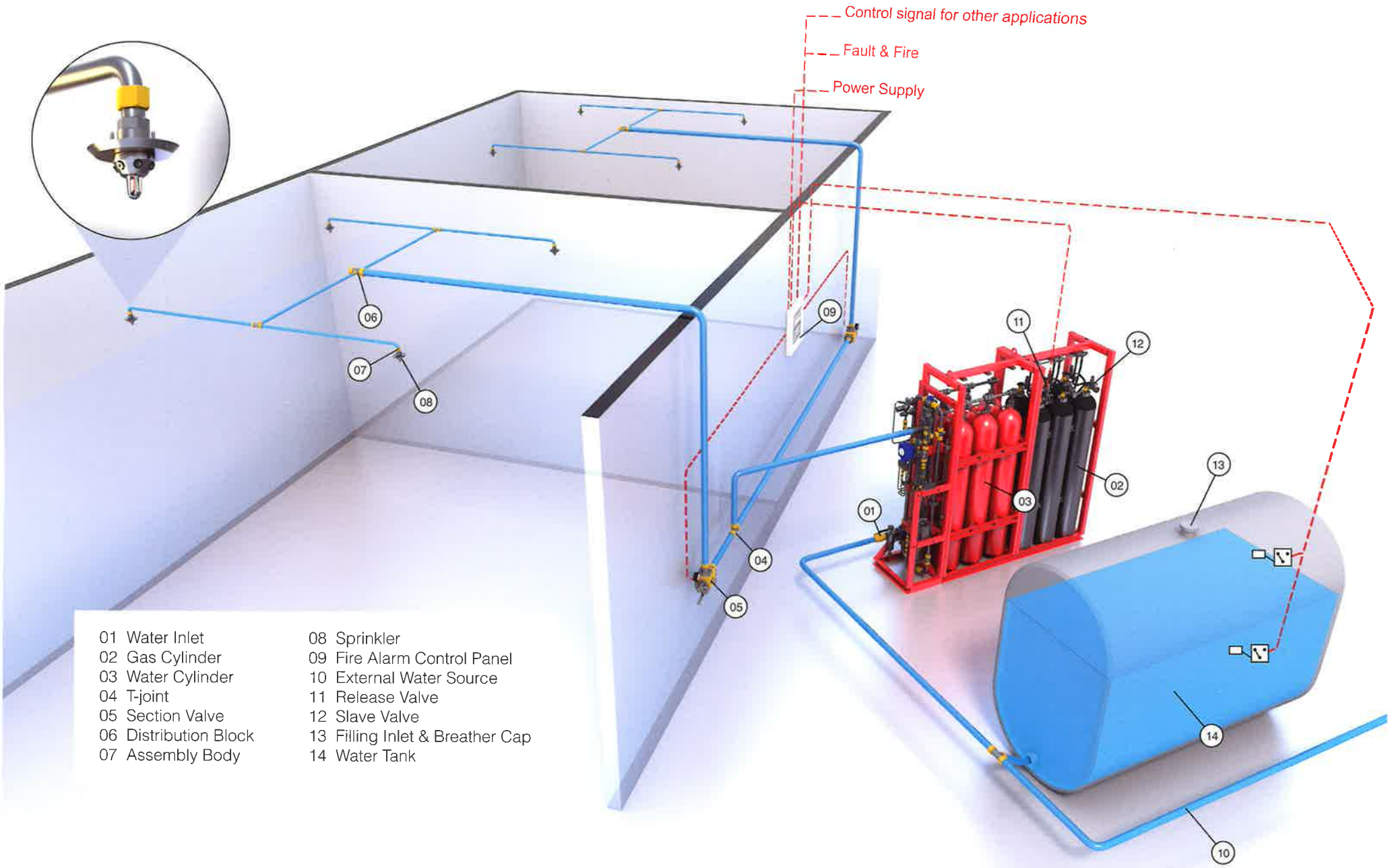
HI-FOG® spray heads



Special nozzles




Control signal for other applications
Fault & Fire
Power Supply
Power Supply
01 Unloading / Test Line
02 Water Inlet
03 Fire Alarm Control Panel
04 Water Tank
05 External Water Source
06 Feed Water Pump
07 T-joint
08 Section Valve
09 Distribution Block
10 Assembly Body
11 Sprinkler
12 Filter Unit
13 Solenoid Valve


Control signal for other applications
Fault & Fire
Power Supply
01 Water Inlet
02 Gas Cylinder
03 Water Cylinder
04 T-joint
05 Section Valve
06 Distribution Block
07 Assembly Body
08 Sprinkler
09 Fire Alarm Control Panel
10 External Water Source
11 Release Valve
12 Slave Valve
13 Filling Inlet & Breather Cap
14 Water Tank











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