



**Water mist fire suppression.
When less is more
for special hazards
protection**

Today's special hazards fire suppression needs to be capable of doing more with less – less water consumption, less environmental impact and less cost in terms of the total cost of ownership. Add to these requirements, the essentials of protecting assets and business continuity, and the outcome is that water mist is becoming the fire suppression choice of data centers, cultural heritage buildings, museums, industrial fryers, and other special hazard applications.

Fire destroys commercial assets worth billions¹ every year, but a good portion of this damage can be attributed to how the fires are extinguished. Traditional sprinkler systems drown out the fire, but the aftermath can be devastating and can spread far beyond the fire. The resulting water damage can take weeks or even months to repair while the business stays down.

Extinguishing a fire at a data center or historical building with large amounts of water can be a case of the solution being worse than the problem. Depending on water pressure, each sprinkler head can discharge between 30–36 gallons per minute, and there are likely multiple sprinkler head activations for a single fire event.

Water mist fire suppression is an effective solution for special hazard fire protection. These are areas or applications that meet one of these definitions:

- Areas containing equipment or processes of exceptionally high value

- Areas containing unique or irreplaceable assets (museums, archives, art galleries or records storage)
- Areas or processes where the revenue produced or its function is of greater value than the equipment itself (industrial cooking, power generation, oil and gas production modules, etc.)

A fire that breaks out in a special hazard area can threaten lives, risk irreplaceable structures and other assets, as well as interrupt process or business continuity. These are often the very sites where certain fire suppression approaches – such as traditional sprinklers – can cause more damage than the fire itself.

The benefits of less

Using approximately 90% less water than traditional water sprinklers, water mist (or fog as it's alternatively referred to) fire suppression systems are highly efficient at fighting fires due to the way they deliver the water.

When a fire is detected, the system discharges a fine water mist. This mist absorbs heat and displaces oxygen at the core of the fire and blocks radiant heat to control, suppress or extinguish fires.

Water mist also helps pre-wet and block heat transfer to adjacent combustibles which decreases the risk that the fire will grow and spread. When dealing with occupied spaces, having a suppression system that dissipates heat and reduces smoke also allows for a safer evacuation and assists in maintaining the structural integrity of the area it is protecting.

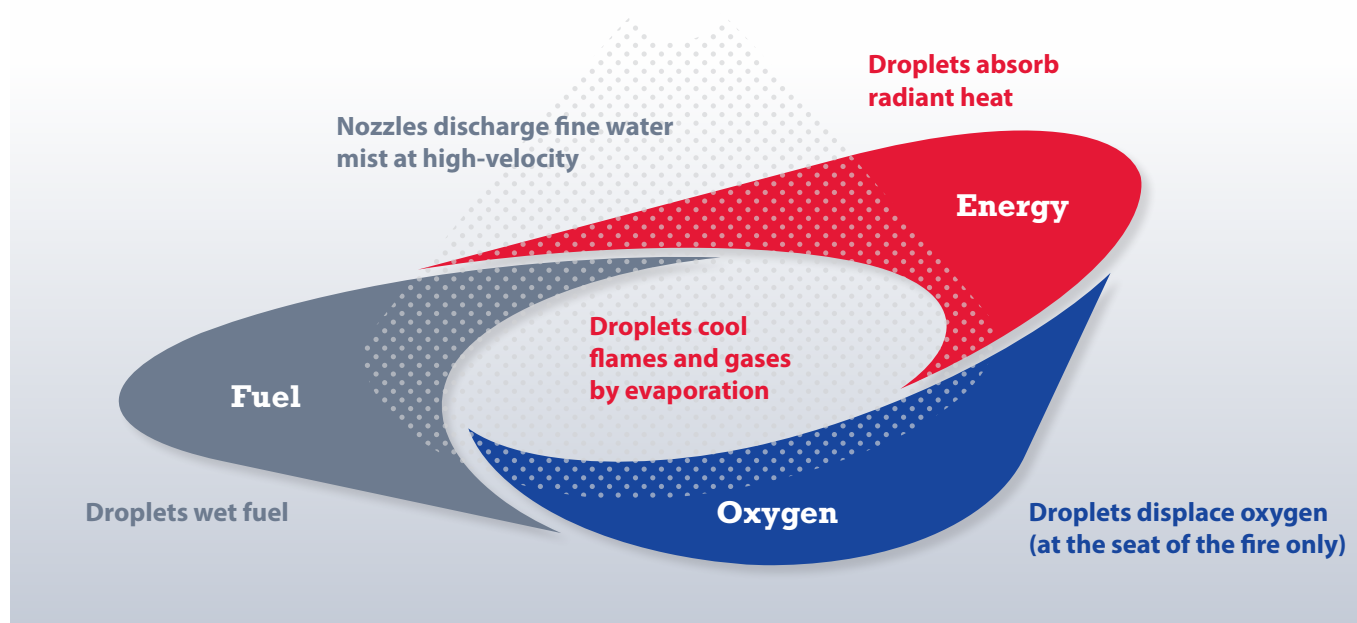
The effectiveness of water mist suppression is due to the size of the water droplets emitted by its discharge heads. To offer an idea of droplet size, sprinkler systems have a droplet size over 1000 microns, low-pressure systems droplets are sized at just under a thousand micron—the thickness of a dime—while intermediate pressure produces 300 to 500-micron droplets. High-pressure systems, which are the most widely used water mist systems today, produce 50 to 100-micron size droplets. These significantly smaller droplets provide a larger surface area for heat transfer/absorption, which causes much of the water mist to be vaporized into steam. This results in the steam expanding 1,700 times its original

volume to provide the radiant-heat blocking, oxygen reduction at the seat of the fire, and the cooling effect necessary for fire extinguishment, while also cooling and diluting any flammable and toxic gases that may be present in the hazard.

Since much of the water is vaporized during the suppression process, water damage to property and critical assets is minimized. Less water also means faster cleanup and minimal business interruption—because spaces can become reoccupied and operational in a shorter time following a fire.

Another benefit of water mist is its smoke-scrubbing capabilities. Smoke is not a gas, but a cloud of very small particles. Because particles stick to the surface of water droplets, water mist has the effect of cleaning the air. This is welcome as the particles involved can be highly toxic or carcinogenic, and smoke inhalation is a major cause of death in fires. Some fires have the potential to produce large amounts of smoke, depending on what is burning as the fuel source. Because smoke can be devastating to equipment, the smoke scrubbing benefit of water mist fire suppression can help protect assets or other areas that may be susceptible to smoke damage.

How Water Mist Fire Suppression Works



Combining the suppression effect of gas and traditional sprinkler systems, high-pressure water mist fire suppression attacks two elements of the fire triangle: oxygen and heat. It also can control the fuel source by wetting and cooling the surrounding fuel surfaces.

Water droplet size is important. Smaller droplet sizes result in a more efficient use of water.

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

Suitable for multiple classes of fire

Water mist fire suppression systems have been used effectively in a variety of applications, demonstrating their capabilities in extinguishing Class A, B, C, and K fires. They have been used for the extinguishment of Class A fires (furniture, paper, and cables) found in office buildings, archives, and heritage properties; the extinguishment of Class B (fuel and lubricants) spray and pool fires in steam or gas turbine machinery spaces, diesel generator rooms, outdoor and indoor oil-cooled transformers, or compressor stations; the extinguishment of Class C fires in computer and electronics equipment, or in electrical rooms. They have also been used for the extinguishment of fires in large industrial oil cooking equipment.²

Traditionally, Class C electrical fires cannot be fought with water; you must use non-conductive substances. However, extensive full-scale fire tests have been conducted to evaluate the feasibility of water mist suppression for the protection of electrical and electronic equipment.^{3,4}

Studies showed that fine water mist was effective in extinguishing in-cabinet electronic and computer room fires, without causing short circuits or other damage to electrical and electronic components. In addition, evacuation of the compartment may not be necessary, and the electronic equipment can be continuously operated during discharge of the water mist system, especially if a zoned water mist system is used.⁵

Water mist also works for Class B fires. Pouring water on

burning oil or fuel can spread the fire, because oil floats on water. Due to the significantly smaller droplet sizes, and the amount of steam dispersion, this is not a problem with water mist.

Water mist systems can be used in the suppression, control, and extinguishment of many types of fires, but they aren't an appropriate substitute for all kinds of fire protection. Like other water-based systems (traditional sprinklers, etc.), water mist may worsen fires containing materials that become dangerous when combined with water, including sodium, potassium, and other reactive substances. As such, the National Fire Protection Association (NFPA) 750: Standard on Water Mist Fire Protection Systems specifically prohibits the use of water mist systems in applications where water may do more harm than good.

Advantages of water mist suppression

Water mist fire suppression offers several advantages over other types of fire suppression such as traditional sprinkler systems, gaseous systems, and chemical foams.

1. WATER EFFICIENCY

The enormous amount of water that traditional sprinklers consume and emit upon discharge can be a problem for locations with limited water supply or where significant water damage is not wanted. According to the World Resources Institute (WRI) writes, "The global growing demand for water is coming into conflict with our finite global water supply."⁶ Aquifer depletion is at historically

high levels in the U.S., and data from the WRI rank several U.S. states (New Mexico, California, Arizona, Colorado, and Nebraska) as facing extremely-high or high strains on water supplies. Another 11 states are ranked as medium-high. With water shortages threatening cities, states, countries and even continents, it is critical that facilities manage all aspects of their water usage, including fire suppression, to minimize their impact on local water supplies. **Note:** The rankings cited above are based on the percentage results derived when comparing how much water is being withdrawn (by homes, industries and agriculture) to how much is available. Higher values indicate more competition among users.

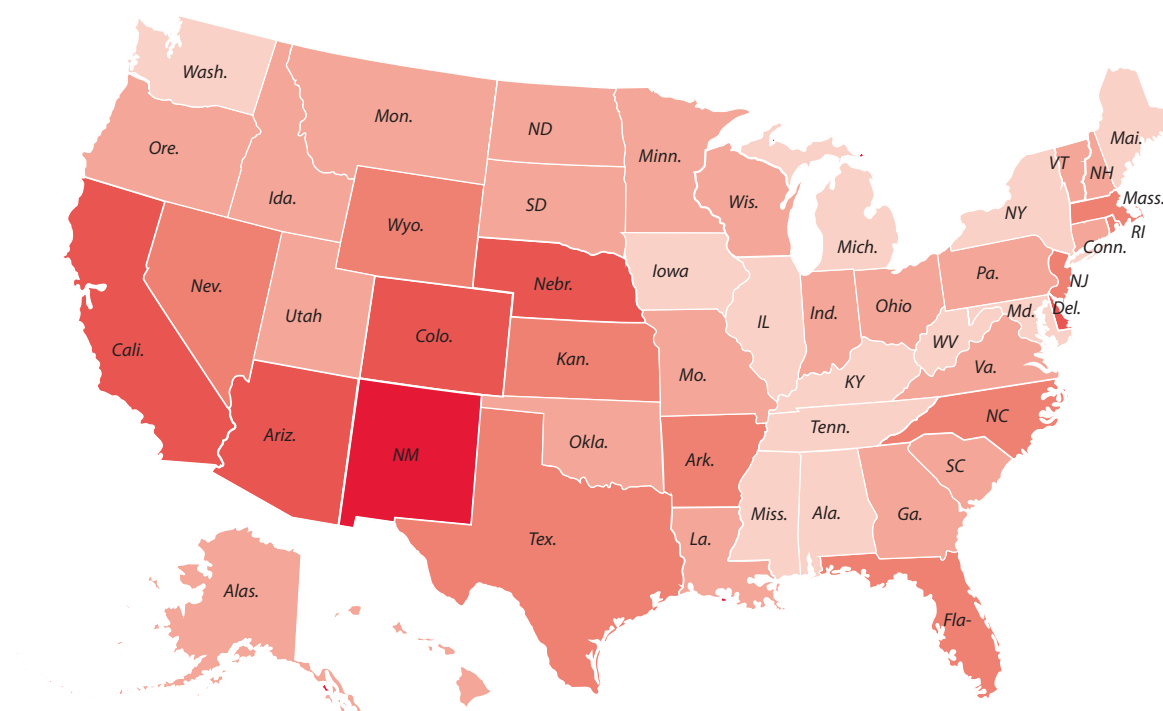
Of course, the other environmentally-sound aspect of water mist is its considerably reduced water usage when compared to traditional sprinklers. High-pressure water mist fire suppression systems can take one droplet of water from a traditional sprinkler and turn it into 8,000

droplets, resulting in faster vaporization and efficient absorption of heat from the fire. Because of this efficiency, water mist fire suppression systems use far less water, typically 50 to 90% less than conventional or pre-action sprinkler systems. Water mist systems can also be used in locations where municipal water pressure is low.

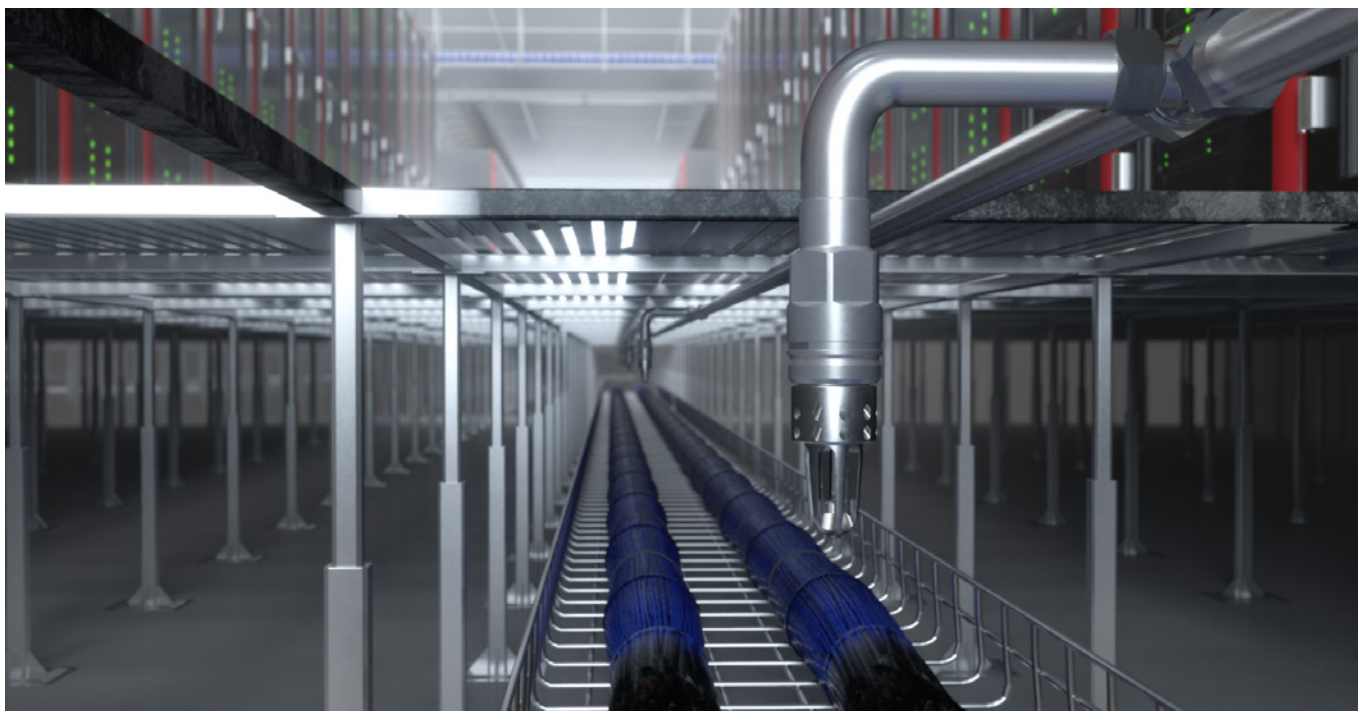
Furthermore, sprinkler systems often use the same water supply as fire hydrant lines and these water sources can contain sediment and other impurities, including corrosion materials from the piping. The presence of large amounts of water in a data center or a cultural heritage building is bad enough; contaminated water is even worse. Water mist systems typically use a potable water source so, concerns with sediment and other impurities would be significantly reduced. The system draws clean, potable water from either a municipal water source or on-site water storage tanks.

A handful of US states—including New Mexico and California—are facing significant strains on their water supplies. The percentages above represent the amount of water that is being withdrawn, compared to how much is available. Higher values indicate more competition among users.

Extremely high (>80%)
 High (40–80%)
 Medium high (20–40%)
 Low medium (10–80%)
 Low (<10%)



Water mist fire suppression can be configured to protect specific areas. This special hazard configuration allows the water mist system to work alongside other fire protection systems.



Know the difference between water mist fire suppression sprinkler and spray heads?

Sprinklers are normally used in systems where the thermal activation of the sprinkler activates the discharge. The heat-sensitive glass bulb in these Marioff HI-FOG® sprinklers (shown) burst at a given temperature, while spray heads have no glass bulb and are used in systems where the discharge is activated through an independent fire detection system.



2. SAFE FOR OCCUPANTS

Water mist as a fire suppression media is safe for the people working or visiting protected areas. This is in contrast to total-flooding carbon dioxide (CO₂) systems, commonly used in engine rooms, generator rooms, power stations, flammable liquid storage rooms, and around large industrial machines. These systems work by significantly reducing the amount of oxygen present in the total space, which in turn starves the fire of this element essential for combustion but reduces the oxygen available to occupants of the space. The risk involved with the use of CO₂ systems is based on the fact that the level of CO₂ needed to extinguish fires (and, thus, to protect an enclosure) is in higher concentrations.⁷ When there is personnel working in fire-protected areas, water mist fire suppression is a good alternative in terms of life safety.

3. NO CLIMATE IMPACT

Unlike chemical compounds such as hydrofluorocarbons (HFCs), water has a zero global warming potential (GWP) rating. There is growing legislation in Europe, the U.S. and other countries that limit the use of ozone-depleting substances. Water is a natural, non-toxic and non-reactive substance.

4. LOWER TOTAL COST OF OWNERSHIP

Although a water mist system may require a larger upfront investment than a conventional sprinkler system, the total cost of ownership may be lower, taking into account the superior durability and lower maintenance costs associated with some manufacturers' water mist systems.

Another water mist attribute is that a more aesthetically pleasing and less intrusive installation is possible due to small pipe sizes, particularly for retrofits, while also reducing the structural loads on the enclosure/building structure.

Water mist fire suppression design approaches

Water mist systems can also be designed to provide various suppression approaches, as described below.

PRE-ACTION

These are designed to activate in the double interlock dry-pipe pre-action style; meaning that two different actions must occur to discharge the water. With smoke detectors or heat sensors operating the valves in both systems, the water is held back from flowing until the frangible temperature bulb on a particular discharge head is activated by the heat from a fire. Only then is the water allowed to flow through the system piping/tubing to the activated sprinkler head.

TOTAL FLOODING

A total flooding water mist system is a dry pipe system designed to discharge mist uniformly throughout the entire enclosure/compartment through open discharge heads, making water mist more cost-effective than other agents, because there is no need to tightly seal the protected space. In contrast, gaseous suppression agents require the complete sealing of all walls, floors, return air ducts, ceiling slabs, doorways and other possible openings to contain the agent long enough to effectively suppress the fire.

LOCAL APPLICATION

Water mist fire suppression systems can be designed to protect specific equipment within a larger enclosure. During the design and installation, the discharge heads must be carefully selected and positioned, within the guidelines of the systems' design manual to provide the required coverage, flow and distribution patterns for the

A variety of spray heads are available to meet a vast range of fire protection applications, including special requirements such as tamper-proof installations and floor mounting heads used in airport hangars. All Marioff HI-FOG spray heads (shown) are made of stainless steel and consist of a body, micro-nozzles and a 300 µm strainer to protect against clogging.



protected assets. In the event of a fire, the system will only discharge water mist in the spaces where a fire's heat signature is detected.

FACILITY-WIDE PROTECTION

Water mist can also be deployed to cover various spaces within the facility not normally protected by special hazard fire suppression, such as office areas, generator rooms, or storage areas that may exist in the same building envelope and are served from the same water mist pump. This means that a water mist system can be the primary fire suppression system for both hazardous and non-hazardous spaces, eliminating the need for traditional sprinklers in areas where water mist is deployed. The bottom line is, water mist fire suppression systems are a viable and cost-effective solution.

Water mist applications

DATA CENTERS

Fire suppression in data centers can be challenging due to the high airflow and the increased power density of servers. Studies⁸⁻¹⁰ have shown that fine water mist is effective in extinguishing in-cabinet electronic fires, as well as fires in the computer room, without causing short circuits or other damage to electrical and electronic components. Areas requiring fire protection can range from an entire building to a single floor, an area, a room, or just specific equipment or assets. Choosing a water mist system rather than a clean agent gas system may eliminate the need for special room alterations or HVAC shutdowns. Backup generator rooms are another critical area within the data center infrastructure because these spaces contain hydrocarbon fuel, which can contribute to very intense fires. Water mist systems are especially effective in rapidly extinguishing these high-energy fires.

INDUSTRIAL FRYERS

Industrial oil cookers are a unique fire hazard in the large-scale industrial cooking industry. Fire protection systems need to extinguish the flames as well as cool down the oil to prevent re-ignition. Using clean, potable water combined with a fine water mist discharge, it penetrates the fire, blocks radiant heat, and cools the oil below its auto-ignition temperature. Providing clean, and fast-acting fire protection, a water mist fire suppression system can bring industrial fryer fires under control

quickly and easily. High-pressure water mist systems are usually configured to provide protection for fryer hood, fines box, takeout conveyor, and the vertical exhaust ducts.

HISTORICAL/CULTURAL HERITAGE BUILDINGS

Water mist fire suppression systems are used in a wide variety of applications that contain high-value assets, including museums, vaults, heritage buildings, churches and art galleries. In each of these settings, it's vital that fire suppression systems do not damage the structures or contents. In the event of a fire, the high-pressure fine water mist rapidly cools and suppresses the fire using minimal amounts of water to preserve artifacts and decorations. Water mist systems also offer installation advantages, because their small, bendable stainless-steel tubes are easy to install, are low-profile and can preserve building aesthetics because they can be tucked behind a variety of design elements, such as crown molding.

POWER PLANTS AND HEAVY INDUSTRY

In industries that rely on uninterrupted operation, a fire can lead to serious consequences. Power generation and industrial process machinery use flammable liquids for fuel, hydraulics, and lubrication. Over time, these oil systems can malfunction causing leakages. The worst-case scenario is when the leakage breaks out close to the hot surfaces of the equipment and a fire results. High-pressure water mist fire suppression systems can protect machinery from fire at the source, keeping damage and downtime to a minimum.



Water mist fire suppression can protect irreplaceable assets in a heritage site, as Marioff's HI-FOG system does today at St. Patrick's Cathedral in New York City.

Adhering to NFPA 750¹¹

This standard contains the minimum requirements for the design, installation, maintenance, and testing of water mist fire protection systems. NFPA standards are used in the development of U.S. and other internationally based fire safety codes.

NFPA 750 brings value and clarity to the industry as it mandates the industry to follow a set of minimum criteria, such as a performance-based testing approach from all water mist providers. This requires manufacturers to test and demonstrate their system performance against real fires prior to customer installations. These can be done in the form of engineered fire tests that are carried out by the manufacturer or by a third-party approval body.

Third-party approvers, such as FM Approvals, have developed certain testing protocols that manufacturers have to pass to be able to claim their systems carry the FM Approval for that test protocol application (machinery space, data center, Hazard Class 1, industrial oil cookers, etc.). Manufacturers may have to carry out engineered

fire tests for certain applications or fire loads when a third-party approval agency does not have a specific testing protocol developed to test against. When testing is completed, the manufacturer will provide a fire test summary based on the completed testing, which can be used for justification for an engineered solution when speaking to an engineer, fire marshal, insurance company, or other interested parties in the process.

Conclusion

Fire safety professionals are now able to do more with less. Facility managers, consulting-specifying engineers, fire system integrators and other professionals are all seeking fire suppression solutions that satisfy competing demands, the demand for less water usage and reduced environmental impact with the necessary protection of assets and/or business operations. For special hazard applications of all types, this balancing act is increasingly weighted in favor of water-mist systems for fire suppression.

Resources

1. Introduction: <https://www.usfa.fema.gov/downloads/pdf/statistics/v1913.pdf>
2. Liu, Z.G.; Kim, A.K., "A review of water mist fire suppression technology: Part II - Application studies"
3. Grosshandler, W., Lowe, D., Notarianni, K. and Rinkinen, W., "Protection of Data Processing Equipment with Fine Water Sprays," NISTIR 5514, National Institute of Standards and Technology, USA, 1994.
4. Carlzon, B. "Fire Protection in Computer Rooms," Nordic conference on water mist applications, Swedish National Testing and Research Institute, SP Report 1997:02, 1997
5. Liu Jianghong, Liao Guangxuan, Li Peide, Fan Weicheng & Lu Qiang, "Progress in research and application of water mist fire suppression technology," 2003.
6. Advantages of water mist suppression: <https://www.wri.org/blog/2013/05/new-study-raises-question-what-don-t-we-know-about-water-scarcity>
7. Carbon Dioxide as a Fire Suppressant: Examining the Risks <https://www.epa.gov/snap/carbon-dioxide-fire-suppressant-examining-risks>
8. Botting, R.E., "Fire Engineering and Research: Fire Detection and Protection of Telephone Exchange Main Distribution Frames, Telecom Corporation of New Zealand Ltd.," Annual Conference of the Institution of Fire Engineers (New Zealand Branch), 1990.
9. Hills, A.T., Simpson, T. and Smith, D.P., "Water Mist Fire Protection Systems for Telecommunication Switch Gear and Other Electronic Facilities," Proceedings: Water Mist Fire Suppression Workshop, USA, 1993, pp. 123-144.
10. Simpson, T. and Smith, D.P., "A Fully Integrated Water Mist Fire Suppression System For Telecommunications and Other Electronics Cabinets," International Conference on Water Mist Fire Suppression Systems, Borås, Sweden, 1993.
11. Adhering to NFPA 750: <https://www.nfpa.org/codes-and-standards/all-codes-and-standards/list-of-codes-and-standards/detail?code=7501>

Marioff is a leading developer of water mist fire protection technology and supplies system solutions worldwide. The company's innovative HI-FOG® water mist fire protection system safely controls and suppresses fire using significantly less water than conventional sprinkler systems, reducing water damage, cleanup time and operational downtime. For more information, visit www.marioff.com.



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