The Station House
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The Water Mist Option: When Does it Make Sense?

by David LeBlanc

Over the last 10 years, water mist has matured from a fire protection tool largely limited to a few marine applications, to an important option for many on-shore protection problems in a variety of occupancies. Some of the key drivers for this growth include; increasing awareness of the dangers of carbon dioxide fire extinguishing systems, environmental concerns associated with fire protection water runoff, and code requirements for retrofit of fixed fire suppression systems in existing structures with very limited water supplies. The other important factors contributing to the increased use of water mist are improvements in the understanding of the behavior of water mist, refinement of installation methods and components, and an increasing availability of high quality, comprehensive approval standards such as the recently released Factory Mutual Approval Standard

As is typical during the early stages of the adoption of new protection methods, there is a wide variation in the understanding of the appropriate use of water mist within the fire protection community. While this is understandable given the overall challenge of keeping pace with an increasing rate of technological development both within and outside of fire protection, there is also the danger that an incomplete understanding can easily lead to the inappropriate use of water mist with potentially significant implications. The purpose of this article is to provide some brief guidance in an effort to ensure that the water mist option is considered when

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Plan Now or Pay Later by *Azarang (Ozzie) Mirkhah, P.E., EFO, CBO*

The NFPA report titled "The Total Cost of Fire in the United States" published last year is an in-depth study of the 2003 national fire loss statistics. The report mentions that even though the total property loss to fire in 2003 was estimated at $14.5 billion dollars, this was only a small part of the overall fire cost, and in reality considering all pertinent factors, the total estimates were as much as 18 times that amount.

According to the report, the complete total cost of fire is estimated at $226 billion to $272 billion, or roughly 2.0 to 2.5 percent of U.S. gross domestic product. The rate of this hemorrhage that is draining our national economy annually is relatively small in comparison to the strength of our national industrial output. But, a quarter of a trillion dollars annual cost is a very significant volume, and demands serious attention.

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appropriate for a particular problem, and is discarded when inappropriate. As water mist is nearly always an alternative to a well-established protection method, there must always be a significant motivation to discard the traditional option.

Categories of Application

There are three major categories of water mist application, with each category defined by different performance objectives and limitations.

Sprinkler System Alternative

The most familiar application of water mist systems is as an alternative to conventional sprinkler systems predominantly for light hazard occupancies. This usage is derived from the first widespread commercial application of water mist to protect shipboard accommodation spaces, areas that are easily correlated to the NFPA definition of light hazard occupancies. In this case, the desired performance of the water mist system is equivalent to the desired performance of a sprinkler system, specifically fire control to protect occupants and building structure until intervention by the fire service.

As water mist is nearly always a more expensive option than a sprinkler system, it is only an attractive alternative when one or more of the following conditions are met;

- Existing water supplies are inadequate, and water supply improvement costs are excessive such as when a structure is located a significant distance from a municipal fire main
- Retrofit of a sprinkler system is required, but disturbance to the structure must be minimized such as in a historically significant property
- There is a significant concern regarding the water damage potential of a traditional sprinkler system such that the client is willing to pay a premium for a reduction in water discharge rate

Water mist used in this manner is functionally similar to a sprinkler system. Specifically, the nozzles are automatically activated using a frangible glass bulb, there are generally no restrictions on the plan area that can be protected, and water supply duration requirements are nominally equivalent. Even though these substantive similarities exist, it is critical to recognize that there are also fundamental differences including;

- Requirements for piping to be corrosion resistant, typically copper or stainless steel tube. Galvanized piping is specifically disallowed.
- Some manner of pumping or pressurization system is nearly always required, as public water supplies rarely supply the necessary pressure
- Specific guidelines related to nozzle placement relative to obstructions or unique ceiling configurations are typically unavailable
- There are limitations on maximum ceiling height, typically around 15 ft

The most common use of water mist systems as an alternative to sprinkler systems is to retrofit heritage properties because frequently all three conditions which make the water mist option attractive are met. While the installed costs of the water mist system are always higher than a comparable sprinkler system (due to the differences outlined above), frequently these costs are offset by a reduction in costs associated with providing a larger water supply and reduced disturbance to the historical due to the comparably smaller pipe sizes of water mist.

Fire Extinguishing System

Another common use of water mist is as a total flooding fire extinguishing system, typically as an alternative to a gaseous agent protecting a flammable liquid hazard. Again, this land based used is derived originally from protecting shipboard machinery spaces such as engine compartments. In this instance, the performance objective of the water mist system is fire extinguishment, equivalent to the gaseous agents it is supposed to replace.

There are several reasons that

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water mist would be selected over a gaseous agent including;

- Safety concerns related to agent discharge in occupied enclosures, particularly in the case of carbon dioxide extinguishing systems
- Poor enclosure integrity retention resulting in high total cost of ownership for gaseous systems
- Desire for continuous discharge system in cases where involved machinery cannot be quickly shutdown
- Fire protection applications where cooling is a key component of the fire damage mitigation plan

Although water mist systems used to protect these hazards are significantly less sensitive to enclosure integrity and leakage than gaseous systems, this does not mean that these parameters can be ignored. The two critical factors affecting the ability of a water mist system to extinguish flammable liquid fires are the overall free enclosure volume, and the total ventilation into and out of the protected space. Specifically, all approved water mist systems are limited to a maximum enclosure volume (typically 50,000 ft^3 or less) and a maximum allowable ventilation opening or rate. One reason for these limitations is that as the size and air exchange rate of enclosure increases, the time required to extinguish a fire similarly increases.

Other important parameters include;

- Total discharge duration is dependent upon enclosure volume, but never less than 10 minutes. Large enclosures will typically require a pumped system while small enclosures can be protected with self contained units
- Systems are configured such that all nozzles discharge simultaneously (deluge)
- Copper or Stainless Steel tube required

One common use of water mist in this application category is for the protection of diesel generator or gas turbine enclosures as an alternative to carbon dioxide systems.

Engineered Fire Solutions

The final broad category of applications for water mist systems is a catchall grouping defined primarily by pre-engineered solutions for very specific and specialized applications. Development of these applications characteristically require very specific fire testing directly related to the application being developed, as opposed to the more broadly applicable fire performance testing used for the previous two application categories. Typically, there are no approval methodologies for these applications, thus ad-hoc fire test programs are required to develop these systems and evaluate performance. Extrapolation beyond the limited cases tested during ad-hoc tests generally makes extrapolation to other cases unadvisable.

Two of the most common examples of these specialized systems include water mist to protect industrial oil cookers and wet benches.

Understanding NFPA 750

The NFPA installation standard for water mist is *NFPA 750: Standard on Water Mist Fire Protection Systems*. While this document has been in existence for more than 10 years, it remains a source of many questions from fire protection professionals. This is primarily because NFPA 750 has very few prescriptive requirements, but is instead a performance-based standard that relies heavily upon demonstrating system performance through fire testing and third party approvals. In practice, this requires designers and installers of water mist systems to work closely with the system manufacturer to develop appropriate system designs.

This is not to say that NFPA 750 is not a useful standard, as it does provide guidance on many important details such as

- Spacing of hangers for copper or stainless tubing
- Requirements for Water Mist Pumps especially positive displacement type pumps which are not common in fire protection applications
- Allowable piping materials and joining methods
- Annex material on performance test methods

As the use of water mist becomes more commonplace, it is anticipated that much of the guidance which his currently lacking in this NFPA standard will be introduced. However, as a fundamentally performance based document, it is unlikely that the level of prescriptive specificity found in standards such as NFPA 13 will be realized. For this reason, it is highly probable that significant involvement of the water mist system manufacturer in the system design process will continue to be the normal practice.

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Sprinkler Success Stories

Sprinkler Saves High School

According to an item in the *San Bernardino Sun,* San Bernardino, California, on November 12, 2005, a toaster oven left on overnight is believed to have ignited a fire that destroyed a classroom and damaged at least five others; causing an estimated $800,000 to $1 million in damage.

The fire didn't burn outside the classroom that is used for special-education students, but the intense heat and smoke damaged two adjoining classrooms and outside hallways.

No sprinklers were in the classroom that caught fire; but sprinklers from the neighboring classrooms activated and thwarted further damage, said Captain Terry Gibbons of the Crest Forest Fire District.

At least three other classrooms sustained water and smoke damage as well, Principal Guy Bonanno said. He said the classroom that caught fire didn't have sprinklers because it was older.

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Sprinkler Controls Unattended Cooking Fire

Connecticut - An 83-year-old man living in an apartment in a building housing older adults evidently started heating a pot of food on his stove when he dropped dead, leaving the food cooking unattended. The food eventually ignited, starting a fire that spread to nearby combustibles until a sprinkler activated and brought it under control.

The three-story steel-frame apartment building, which was 300 feet (91.4 meters) long and 75 feet (22.9 meters) wide, had concrete block walls and concrete floors. It was protected by a wet-pipe sprinklers system and a hardwired smoke detection system that provided coverage to the sleeping areas and hallways.

The building's occupants were alerted to the fire by the water flow alarm and hallway detectors, and the central station alarm company alerted the fire department at 11:29 p.m.

Discovering that the sprinkler had extinguished most of the fire, responding firefighters used a portable fire extinguisher to complete extinguishment.

Losses to the building were estimated at $40,000; damage to its contents was estimated at $5,000.

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Conclusion

A review of the myriad of water mist system configuration and approvals can be extremely confusing when trying to select the best fire protection option for a hazard. One of the best ways to simplify this process, and to quickly determine when water mist is a potential option is to select the specific application category of a system, i.e. sprinkler system alternative or gaseous system alternative, and then identify if any of the critical drivers which might encourage the decision to use water mist are in place. As water mist is nearly always a newer, less understood alternative to existing protection methods typically the systems will only be employed when there is a compelling, client driven reason for selecting this option.

The lack of prescriptive guidance in NFPA 750, and the limited number of broadly applicable approval standards requires that the successful implementation of a water mist system include the direct client, the system designer and contractor, and the manufacturer. Although it may take a bit more work to install a water mist system, increasing environmental pressures and requirements for retrofits combined with decreasing water supply availability will ensure the continued growth of this technology.

David Leblanc is the Director of Engineered Systems for Tyco Fire & Building Products

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It's our professional obligation to focus on ways to significantly reduce these losses. In the competitive world of global economics, we must be concerned about such wastes. We need the foresight to look ahead 30-40 years and recognize that to be competitive in the global economy, we should focus on ways to decrease our total national fire cost.

Flat Plate Concealed Fire Sprinklers like the one pictured above are less obtrusive than speakers and typical light fixtures

Unfortunately many fire protection professionals have yet to fully recognize the importance of better utilizing sprinkler technology to assist us in this battle. We seem to accept the high number of casualties and the associated economic losses. It also appears that we have become accustomed and consider them as collateral losses, or in an essence an "acceptable risk".

The NFPA report titled "Fire Loss in the United States During 2004" states that, "with home fire deaths still accounting for 3,190 fire deaths or 82 percent of all civilian deaths, fire safety initiatives targeted at the home remain the key to any reductions in the overall fire death toll." In addition, NFPA statistics show that smoke alarms and residential sprinkler systems together reduce fire death rates 82 percent.

For the fire protection industry to be able to successfully address this problem, the question to be answered is what could be done to reverse the trend and significantly reduce the total national fire cost? Reliance on technology could provide some of the answers. I am a strong proponent of utilizing any and all available technologies, including the sprinkler systems technology, to assist us in accomplishing our goals. I believe that residential fire sprinkler systems could drastically reduce the total number of fire fatalities and decrease the overall adverse cost impact of fires on our national economy. The installation of the residential fire sprinkler systems in all new homes as recommended in the newest versions of NFPA 101®, Life Safety Code®, and NFPA 5000®, Building Construction & Safety Code®, would not be an immediate solution but it could be a long-range solution.

Today, new homes are constructed without the protection of the residential fire sprinkler systems. Just like the lumber industry that routinely plants new trees to be harvested in future; today's new homes that are constructed without residential fire sprinkler systems could become part of tomorrow's fire-loss statistics.

BlazeMaster CPVC pipe is an efficient and inexpensive way to install home fire sprinkler systems

Residential fire sprinkler systems are life-safety systems that are designed to save lives by increasing the survival window and avoiding flashovers by stopping the fire's progression. This would allow the occupants more time to evacuate and save their lives. The fire sprinklers operation would also create a safer environment for the responding firefighters in their interior search and rescue, and their fire suppression operations.

So, if residential sprinklers can help prevent fatalities and limit property damage then why shouldn't we strongly promote installing them in all our new homes? Yet, according to NFPA statistics, only 7 percent of our homes are protected by sprinklers.

Why? Because we have been so divided for so long, and yet our opposition has been well organized and unified. After two decades, isn't it time that we all got on the same page and put our support behind this technology that can save lives and also reduce our total national fire cost?

It is said that "there's absolutely no way that you can convince others, over the long term, to share a dream if you're not convinced of it yourself. You must be sincere in your own belief."

We must develop and deeply believe in the common goal of reducing the fire fatalities and injuries, and also decreasing the total national fire cost.

We must then use every single opportunity to promote the importance of utilizing any and all technologies, including the residential fire sprinkler systems technology, in accomplishing those goals. Let's face it reducing the total national fire cost is not only our professional obligation, but it is also our patriotic duty.

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Lack of operating smoke alarms leads to fire death

Pennsylvania - The failure of nob-and-tube wiring in the attic of a single-family home is believed to have started a fire that killed one of the occupants.

The three-story, wood-frame house, which measured 24 feet (6 meters) by 24 feet (6 meters), had a metal roof and a brick veneer. There was a single-station, battery-operated smoke alarm on each floor, but investigators found that some alarms had been deactivated. The unsprinklered house was rented to five unrelated individuals who boarded in separate rooms. A large party had been held the night before.

The driver of a trash truck saw the fire and called in the alarm at 6:44 a.m. A police officer arrived within one minute of the alarm and entered the house to alert the occupants. He found it filled with 15 to 20 people. Halfway up the stairs from the second floor to the third, the officer was stopped by heavy fire and smoke at ceiling level.

Fire crews arrived minutes later to find smoke and flames coming from the roof of the house. Learning that people were still trapped on the third floor, the incident commander ordered an additional alarm while engine and aerial units established a water supply, raised the aerial ladder, and advanced hose lines into the building. Ground ladders were positioned on all sides of the building, and backup hose lines were taken to the upper floors, as firefighters tried to make it up to the third floor. Eventually, the commander withdrew the firefighters from the interior and ordered master streams and ladder pipes to knock down the heavy fire.

When firefighters reentered the house, they discovered the body of a 21-year-old man in a chair in a rear-facing bedroom on the third floor.

Investigators determined that the occupants had a large party the evening before and that many guests had spent the night. With no smoke alarms to alert them, they were still asleep when the police officer arrived. Two occupants of the third floor climbed out a window and fell to a roof below, while two others on the third floor made their way to the stairs and left with the police officer.

The investigators believe the nob-and-tube wiring above the third-floor attic failed, starting the fire, which burned unnoticed until it broke through the roof.
Four firefighters suffered minor injuries, but everyone in the house except the victim escaped injury. Damage estimates were not reported.

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