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# Fireline

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# Sprinkler Obstruction Investigations

## Microbiologically influenced corrosion is a major cause of sprinkler system obstructions. How can it be detected and controlled?

BY BRIAN SAUER

For sprinkler systems to be effective for fire control and extinguishment, internal piping and sprinkler heads must be free from obstructions, such as scale, silt and other foreign organic and/or inorganic material.

NFPA research shows that sprinklers were effective 96% of the time when they operated. In the other 4% of the cases, ineffectiveness was related to water not reaching the fire 42% of the time and lack of maintenance 3% of the time. Although the author has not found any NFPA statistics that directly track the ineffectiveness of sprinklers because of obstructions, it has been recognized as a potential problem that is now addressed in NFPA 25, Standard for the Inspection, Testing and Maintenance of Water-Based Fire Protection Systems.

*NFPA research shows that sprinklers were effective 96% of the time when they operated.*

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## Sprinkler Obstruction Investigations

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Chapter 13 of NFPA 25 (2002 Edition), which is currently adopted by the Indiana Fire Prevention and Building Safety Commission and, therefore, referenced within the Indiana Fire Code (2008 Edition), outlines requirements for obstruction investigations that include the "minimum requirements for conducting investigations of fire protection system piping for possible sources of materials that can cause pipe blockage." The chapter uses terminology reflecting three categories as they relate to obstruction investigation and prevention programs: 1) internal piping examinations; 2) obstruction investigations; and 3) flushing procedures.

An investigation of piping and branch line conditions (internal piping examination) is required to be performed every 5 years in accordance with Section 13.2.1. This was a new requirement in the 2002 Edition of NFPA 25 and is mandatory for all sprinkler systems, including wet systems. The internal piping examination requires the opening of a flushing connection at the end of one main and the removal of a sprinkler toward the end of one branch line. This requirement checks for the presence of microbiologically influenced corrosion (MIC). Any tubercules or slime, if found, is required to be tested for the presence of MIC.

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MIC can affect none, some or all of the sprinkler systems within the same building, occurring in one or more risers and not necessarily in another. A former authority having jurisdiction (AHJ) expressed his experience with a facility that had 12 separate sprinkler risers, two of which contained MIC while the other 10 did not. This confirms that examining one sprinkler system in a facility with multiple systems will accurately confirm or deny the presence of MIC.

Also, despite the fact that MIC is not an issue with CPVC plastic sprinkler piping or that manufactured with new internal biofilms, there is no exception within NFPA 25 to eliminate the internal piping inspections. Therefore, to ensure compliance with NFPA 25 requirements, 5-year internal pipe examinations must also be performed on sprinkler systems containing plastic pipe the same as if it was metallic.

Although possible with wet pipe sprinkler systems, internal piping obstructions are more likely in dry pipe systems, preaction systems and sprinkler systems supplied by a fire pump drawing off an open pond or reservoir. An obstruction investigation is triggered by NFPA 25, Section 13.2.2 if one of 14 conditions exist, including identification of pinhole leaks, plugged sprinklers and foreign material observed in water during drain tests or plugging of inspectors' test connections, to name a few.

*Photo 1: Pitting inside of piping. Photo provided by the American Fire Sprinkler Association*

*Photo 2: Pitting that remains after chemical cleaning of the pipe to remove tubercles. Photo provided by the American Fire Sprinkler Association.*

*Photo 3: Microbiologically influenced corrosion. Photo provided by Potter Electric Signal Co.*

*Photo 4: Internal pipe corrosion and hole in galvanized sprinkler piping. Photo provided by Potter Electric Signal Co.*

*Photo 5: Hole created in sprinkler piping by MIC. Photo provided by Potter Electric Signal Co.*

*Photo 6: MIC tubercles inside of galvanized Schedule 40 prinkler piping. Photo provided by Potter Electric Signal Co.*

Obstruction investigations are more labor-intensive and thorough than the internal piping examination required by Section 13.2.1. Obstruction investigations require the internal examination of the system valve, riser, cross main and a branch line. Hoses are attached to several carefully selected cross mains and branch lines with burlap bags attached to the hose end. Water is flowed through the sprinkler system and out the hoses with any foreign material that may be present in the system piping collected in the burlap bags. If the obstruction investigation reveals less than ½ cup of scale washed from cross main(s), scale fragments not large enough to plug sprinklers or full unobstructed flows are obtained from the branch line(s), the system can be considered reasonably free from obstructions.

If this is not the case and the sprinkler system is found to be obstructed, a flushing procedure is mandated by NFPA 25, Section 13.2.4. Flushing procedures must be performed by qualified personnel and require a thorough flushing of the entire system beginning with the yard mains, followed by the sprinkler riser(s), then the feed main(s), cross main(s) and branch line(s).

Flushing procedures can be performed using the hydraulic or hydropneumatic method. The hydraulic method involves using available system pressure and flowing water strategically through each system component, in the same direction water would flow during a fire, and is effective on obstructions comprised of loose material. The hydropneumatic method uses a special piece of equipment that takes compressed air and about 30 gallons of water and blows it from the end of a branch line back through the system piping and out an opening at the base of the riser. This method is necessary for compacted obstructions that normal system pressure will not move.

In summary, within the scope of NFPA 25, 2002 Edition, Chapter 13, one is mandated to determine whether a problem exists with internal obstructions and/or MIC by completing an internal piping examination and obstruction investigation. If findings are inconclusive and no obstructions are found, then no further action is required. If obstructions are large enough to potentially plug sprinkler heads, NFPA 25 mandates correcting the problem by having qualified personnel perform a thorough flushing procedure by one of the two methods mentioned.

**Building maintenance personnel may suspect that MIC is present because of pinhole leaks in the pipes, increased amount of debris in the pipes, plugged sprinkler heads or due to the water's color or smell.**

### MIC & Its Causes

Microbiologically influenced corrosion is a mode of corrosion-incorporating microbes that react and cause corrosion or influence other corrosion processes of metallic materials.

MIC is caused by bacterial microbes in combination with four other environmental conditions: metals, nutrients, water and oxygen. These MIC-causing bacteria are commonly found throughout all types of water supplies. If the water in a sprinkler system tests positive for these bacteria, it does not mean that MIC will develop. All five environmental conditions must be present in a sprinkler system to cause the rapid growth of MIC-related bacteria.

### Why MIC Is a Concern

As MIC bacteria grow, consumption of the metal pipe occurs and can result in the formation of tubercles. During this process, pitting of the interior lining of the sprinkler pipe may occur. Regardless, the hydraulic characteristics of the sprinkler pipe are negatively impacted by the tubercles. Last, the tubercles and loose scale can cause sprinkler heads or valves to become blocked or to not function properly if pieces break free during a water flow event.

### MIC Detection

Building maintenance personnel may suspect that

MIC is present because of pinhole leaks in the pipes, increased amount of debris in the pipes, plugged sprinkler heads or due to the water's color or smell. The least intrusive method to determine whether bacteria associated with MIC are present is to test the liquid within the pipe. The best way to determine whether MIC is in pipes is to take out sections and have them evaluated by a microbiologist or metallurgical engineer. This process also allows for other types of corrosion to be found.

### Testing for MIC

NFPA 25 requires an obstruction inspection every 5 years or whenever there is evidence of rust, foreign debris or pinhole leaks. Further, it requires that if any tubercles or slimes are observed, they shall be tested for indications of MIC (NFPA 25-2002, Section 13.2.1.2). MIC test kits are available commercially for contractors to sample foreign material and submit it for laboratory analysis and confirmation of MIC. If MIC is found, a combination of flushing the sprinkler system and chemical treating of the water may be needed.

A new section in the 2007 Edition of NFPA 13 requires the building owner to give the installing contractor an owner's certificate "detailing any special knowledge of the water supply, including known environmental conditions that might be responsible for corrosion, including microbiologically influenced corrosion" (reference Section 4.3). States that have previously adopted older versions of NFPA 13, such as Indiana, using the 1999 edition, may not have this as an enforceable requirement.

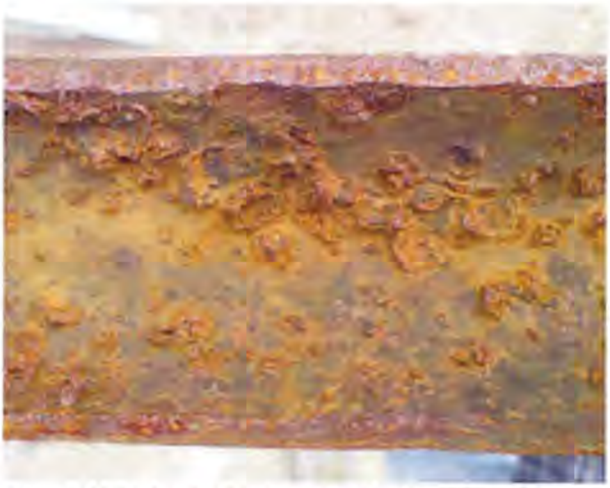

*Photo 7: MIC tubercles (biodomes) inside of sprinkler piping. Photo provided by Potter Electric Signal Co.*

*Photo 8: Scale that can form in dry pipe sprinkler systems that can break off and clog pendant-type sprinkler heads. Photo provided by U.S. Automatic Sprinkler Corp.*

### MIC & New Sprinkler Systems

FM Global provides the following advice for preventing MIC in new systems. MIC prevention should include some or all of the following steps:

•**Step 1.** Diagnose the water supply to help determine whether there is a tendency for corrosion and if the necessary nutrients are present that will support bacterial growth. The alkalinity of the water (pH) must be determined as well as the amount of suspended solids (turbidity), total organic carbon and chemicals, including sulfates. The level of residual disinfectants from the municipal drinking water treatment is also evaluated to determine if additional disinfectants may need to be added.

•**Step 2.** Assess possible alternatives to see whether other water supply sources that may be superior in quality are available. Usually the best source ends up being the municipal system, and as such, would require the least amount of treatment to make the water satisfactory for preventing MIC.

•**Step 3.** Treatment of the local water source with biocides or disinfectants at the point where it enters the system should be done to kill or control the bacteria causing MIC. Corrosion inhibitors will also be needed as part of the overall treatment plan. All incoming water should be treated but in nonrecirculating systems, achieving the required concentrations in all areas of the system can be a challenge. One of the most cost-effective treatments for the bacteria is a weak solution of chlorine (usually 50 ppm or less).

•**Step 4.** Installation of clean pipe and exercising proper care during system acceptance testing are critical to limiting the possibility that MIC-causing microbes will enter the system and later cause problems. No piping that is rusted or otherwise corroded should be installed, and no untreated water should be used to charge the system during testing.

### MIC & Existing Sprinkler Systems

FM Global recommends the following actions if MIC is discovered at a facility:

•**Step 1.** Diagnosis of the corrosion and of the piping condition are required to assess the extent of the damage and whether further treatment is feasible following FM Global's guidelines. Piping samples should be removed and sent as is without removing any scale or corrosion from the surface so the metallurgical laboratory can also analyze the residual materials in the piping as well as the piping itself.

•**Step 2.** Assessment of possible alternatives is done as noted for new systems.

•**Step 3.** Cleaning of the piping is required to remove the scale and debris and should only be undertaken by professionals according to a predetermined written plan. All surfaces should be cleaned down to bare metal. New technology has made it possible to chemically clean the piping in place. This should be done according to FM Global guidelines, including test samples of pipe and metallurgical examination following the cleaning. Any sprinkler heads removed for flushing of the system with the cleaning solutions should not be reinstalled but replaced with new heads after cleaning is complete.

•**Step 4.** Treatment of the local water with disinfectant and biocides similar to the process described for a new system.

•**Step 5.** Recharge the system and go through the acceptance testing process. This includes charging the system to the proper hydrostatic test pressures any time sections of piping have been replaced and after the cleaning process has been completed. Only treated water should be used to minimize the risk of recontaminating the system.

### MIC Mitigation Tools

MIC test kits are available for the sprinkler system owners to collect and determine whether certain types of bacteria are present in the water supply that will cause MIC to develop. Samples from the water supply are drawn and injected into vials containing bacteria-specific nutrients that cause a visual color change after an incubation period. They are intended to only be one indicator and should not be relied upon solely to determine the presence of absence of MIC-producing bacteria.

Automatic chemical delivery systems deliver water treatment solutions directly into the system whenever a water flow is detected. This prevents untreated water from being introduced into the system that could infect it with MIC-producing bacteria, such as during normal flow testing.

Advances in chemical cleaning agents now allow for cleaning of the piping in place but require installation of at least temporary recirculation loops to ensure the delivery of the proper concentrations of solutions to all areas.

### Conclusion

MIC, one of the major causes of sprinkler system obstructions, can be controlled in new systems and the effects often reversed in existing systems through proper controls. While the costs of prevention, such as installation of a water treatment system on the riser, can cost several thousand dollars for the equipment alone, as estimated in the appendix of FM Global Loss Prevention Data Sheet 2-1, restoring a system that has suffered significant damage can cost much more if the repairs involve flushing and partial dismantling of the system to replace severely damaged components—not to mention the risk of system failure during a fire before the internal conditions may be discovered. ○

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