Rehabilitation of Fire Sprinkler Systems Affected by Corrosion -
The piping dilemma: Wholesale or partial replacement?

Ockert J. Van Der Schijff, Pr.Eng., Ph.D.
President
CorrConsult, LLC
55 Constitution Street
Ashland, MA 01721
Tel: (617) 320-9111
Fax: (508) 881-8535
E-mail: info@CorrConsult.com
Web: http://www.CorrConsult.com

The rehabilitation of fire sprinkler systems affected by internal corrosion is a topic that is often debated amongst owners and installers of such systems. Once a system has been diagnosed with internal corrosion, it is usually a challenge to determine the extent and severity of the damage. Partial pipe replacement is almost always a necessity due to the irreversibility and detrimental effects of corrosion damage. Both the accumulation of corrosion product deposits, as well as the degradation (metal loss) of the pipe wall negatively impact the hydraulic characteristics of the sprinkler piping and lower the integrity of the fire protection system in locations where significant wall penetration have taken place. In many instances, owners feel compelled to condemn the entire system, resulting in wholesale removal of piping and replacement with new pipe. This is a very expensive procedure due to the costs associated with demolition of the existing pipe, installing new pipe in an already crowded ceiling space, as well as the intangibles associated with disrupting normal operations to complete the task. Past experience has proven that the location and severity of corrosion damage can be determined effectively by performing a condition assessment of the fire protection system. Due to the corrosion mechanisms at work, corrosion damage in dry and preaction systems is usually located in areas where trapped water has accumulated at low or inadequately sloped sections of the system.

Figure 1 is a screen capture from a video-borescope inspection of a 3” main showing the accumulation of corrosion product deposits below the air/water interface. However, in Figure 2, another section of the same system where there was no residual water shows no significant corrosion damage.

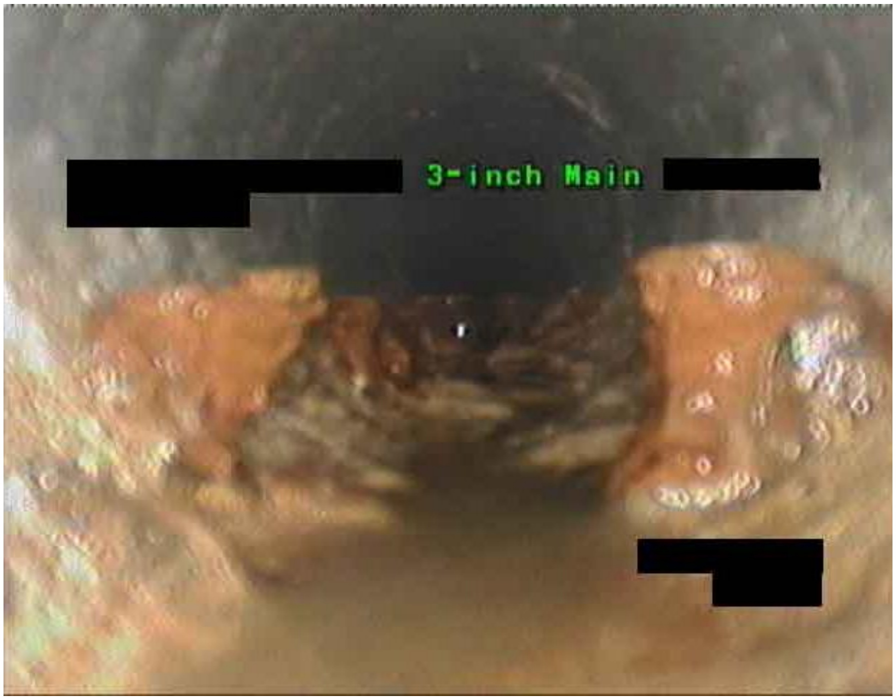

Figure 1. Video-borescope screen capture from pre-action sprinkler system inspection showing accumulated corrosion product deposits below the air/water interface at approximately the 4 and 8 o'clock locations.

Figure 2. Video-borescope screen capture showing no corrosion other than normal zinc oxidation in pre-action system without residual water.

This very clearly illustrates the fact that the piping that was not exposed to residual water is in good condition with no need for replacement. Our past involvement with numerous such systems has shown that the corrosion damage is almost always confined to the larger diameter mains and cross-mains. These are often long pipe runs that were difficult to pitch properly at the time of installation. Branch lines, however, are typically shorter and can be pitched more appropriately and consistently towards the mains and cross-mains. As a result, there is very little trapped water accumulation and low potential for corrosion damage in branch lines. The thicker walls of the Schedule 40 pipe that is most often utilized for small diameter branch lines also helps to make them more "forgiving" in terms of the wall loss due to corrosion.

Conversely, in wet sprinkler systems, the corrosion is usually located at high points in the sprinkler piping where trapped air pockets can exist. Trapped air will eventually rise and accumulate at the highest points in a sprinkler system, creating an air/water interface, which results in corrosion damage at the higher elevations in affected systems as shown in Figure 3.

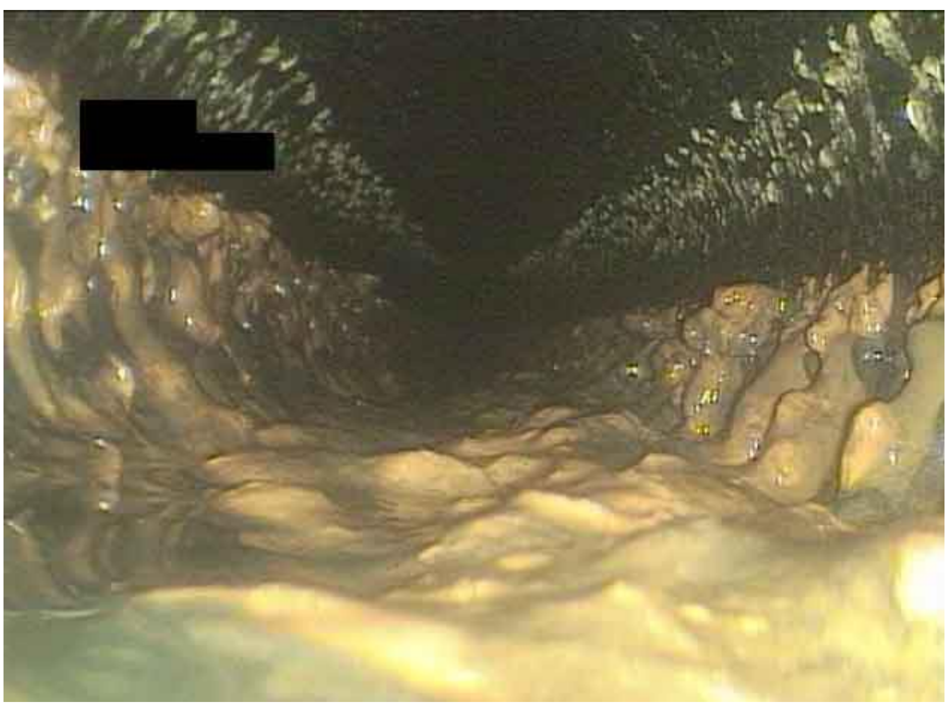

Figure 3. Video-borescope screen capture from wet sprinkler system inspection showing accumulated corrosion product deposits below the air/water interface at approximately the 3 and 9 o'clock locations.

The piping at the lower, water-submerged locations lacks the air/water interface and therefore does not show any corrosion other than the normal layer of black magnetite, which forms as a result of limited uniform corrosion driven by the dissolved oxygen in the charge water.

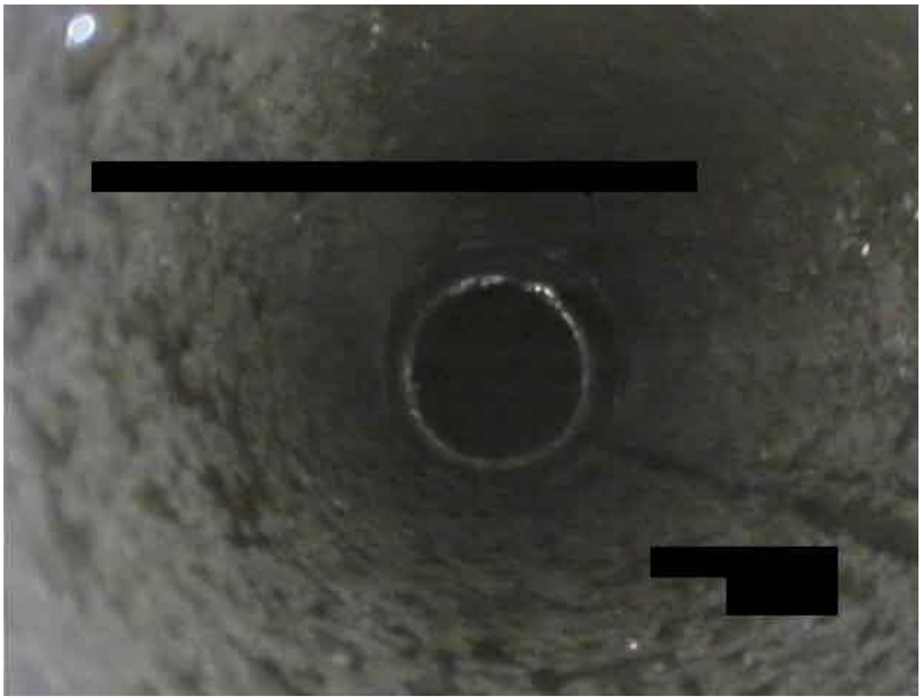

Figure 4. Video-borescope screen capture showing no corrosion other than normal zinc oxidation in pre-action system without trapped air.

Based on our past experience with condition assessment and rehabilitation of corrosion-affected fire sprinkler systems, 10 to 30 percent of the piping is typically replaced selectively. The main attributing characteristics shared by troubled dry and preaction systems are the availability of oxygen (i.e. supervisory air pressure is maintained with an air compressor) and accumulation of water at low or inadequately sloped sections of the system. In addition, historical trending will show that the majority of repairs on these systems occur along the same poorly sloped sections of piping where there is residual water. Pinhole leaks typically develop within two to four years in galvanized pipe at the air-water interface and at the 6 o'clock location under accumulated corrosion product deposits. In black steel pipe, it typically takes longer, but eventually pinhole leaks will appear at the same locations. The localized pitting will continue until all residual water is removed from the system, the slope of the piping is corrected, and if practical, auxiliary low point drains are added. The branch lines and other properly sloped sections of the system are usually unaffected by corrosion due to the lack of water accumulation in such areas. In wet systems, the corrosion damage and pinhole leaks occur along the air/water interfaces located at or near the high points in the system where trapped air accumulate. The remainder of the piping that is fully submerged in water typically shows a thin, dense layer of black magnetite on the pipe surface, but no ongoing localized corrosion. That is due to the self-limiting character of corrosion in these areas where the dissolved oxygen in the water is quickly consumed to form magnetite, but thereafter corrosion effectively stops until the next time the system is charged with oxygenated water. Therefore, wholesale pipe replacement in dry, pre-action, or wet systems is not warranted or necessary to restore them to original design specifications.

There are various techniques that may be employed during a condition assessment, such as spot removal and testing of pipe spool samples, analysis of past leakage history, internal video-borescope inspection, and ultrasonic scanning. Condition assessments can take place outside of normal business hours with the assistance of qualified sprinkler technicians. In most instances, targeted inspections can be conducted during one to three 12-hour nighttime shifts. With the results of the assessment in hand, experienced engineers can identify affected piping, establish trends, and delineate the piping that is most likely to be affected by corrosion. The affected piping can then be selectively replaced, thus preserving a large portion of the unaffected, original piping. This translates to significant materials cost, as well as time savings. The pipe replacement efforts can also be scheduled to occur during times that will have minimal impact on normal business operations. In addition, any modifications to eliminate recurrence of corrosion damage (such as the installation of nitrogen supervisory systems and auxiliary low point drains in dry and preaction systems, or automatic vents in wet systems), can be implemented at the same time.