White Paper

Current Recommendations Regarding the Use of Galvanized Steel Sprinkler Piping within the Fire Protection Industry

(September 2018)

By Jeffrey T. Kochelek

Original article published in Sprinkler Age Magazine, September/October 2018 issue.

Engineered Corrosion Solutions™

Complete Corrosion Control.

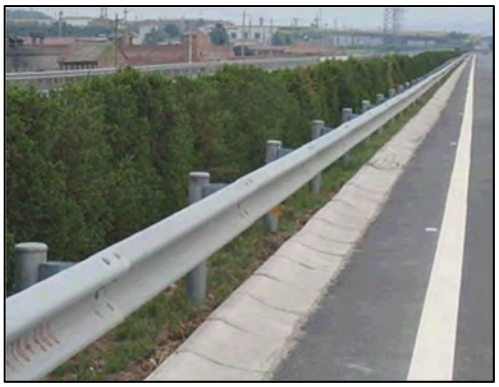
Engineered Corrosion Solutions, LLC
11336 Lackland Road
St. Louis, MO 63146
314-432-1377
ecscorrosion.com

ECS Engineered Corrosion Solutions
ecscorrosion.com

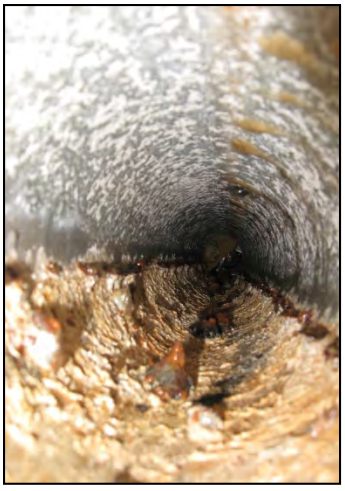
Background

The use of galvanized steel is an excellent means of preventing corrosion by oxygen under the right conditions. The galvanizing process involves the application of a thin layer of zinc to the surface of steel to protect it from corrosive attack. Hot Dip Galvanizing (HDP) and Electroplating are the two (2) most commonly used techniques for applying the zinc layer to steel.

The thin zinc layer on steel provides resistance to corrosion by two (2) mechanisms: First, it acts as a sacrificial anode when attached to steel because it will corrode preferentially under corrosive conditions thereby protecting the underlying steel. Second, in the presence of moisture zinc reacts with oxygen and carbon dioxide from the air to form a protective coating of zinc carbonate (passivation) when it dries out. Under atmospheric exposure when it can dry out, galvanized steel works quite well on guard rails, corrugated roofing, flag poles and street signs because it forms a protective coating of zinc carbonate (Galvanized Guard Rail).



There are conditions when galvanized steel will corrode. Under persistently moist, oxygenated conditions, galvanized steel will corrode aggressively[1]. This occurs because the protective zinc carbonate coating is not stable if the surface remains moist. Under these conditions, the zinc layer will continue to dissolve and expose the underlying steel to aggressive, highly localized attack by oxygen at the point of the initial breach of the zinc layer.



Galvanized steel performs very poorly in dry and preaction fire sprinkler systems when there are pools of trapped water standing within the piping (3-Year Old Galvanized Dry Pipe). Oxygen in the pressure maintenance air dissolves into the water and aggressively attacks the zinc coating. Since it is virtually impossible to remove all the moisture, galvanized piping can fail in 2-3 years after installation[2]. In this instance the only way to protect galvanized steel sprinkler piping is to eliminate the oxygen gas using nitrogen displacement with an FM Approved nitrogen generator for pressure maintenance.

ECS Engineered Corrosion Solutions
ecscorrosion.com

NFPA 13 Installation Standard (2016 Edition)

The 2016 Edition of the NFPA 13 Installation Standard does not require the use of galvanized steel piping in dry and preaction sprinkler systems. All of the current galvanized pipe references:

- 6.8.3.3 – All piping to water motor-operated devices shall be **galvanized** steel, brass, copper, or other approved metallic corrosion resistant material of not less than ¾" pipe size.
- 22.21.2.9.1 – Cooling Tower Fire Sprinklers - Piping, fittings, hangers, braces, and attachment hardware including fasteners shall be hot-dipped **galvanized** steel in accordance with ASTM A153A/153M.
- 26.2.4.1 – Marine Supply System Piping – Requires hot dipped **galvanized** piping after fabrication as opposed to installing galvanized components.
- A.8.16.4.2.1 – External Corrosion of Sprinkler Piping - Where moisture conditions are severe but corrosive conditions are not of great intensity, copper tube or **galvanized** steel pipe, fittings and hangers might be suitable. The exposed threads of steel pipe should be painted.

FM Global – from Property Loss Prevention Data Sheet 2-1 *Corrosion in Automatic Sprinkler Systems* (October 2017)

- 2.2.1.4 – Do not use **galvanized** pipe in a wet system.
- 2.2.1.10.1B – Black steel pipe is acceptable in dry-pipe and preaction sprinkler systems if nitrogen will be used throughout the life of the system. If it will not, use galvanized steel pipe.
- 2.2.1.10.2A – Dry-Pipe and Preaction Systems Not Using Nitrogen, and Deluge Systems – use **galvanized** steel pipe.
- 3.5 – **Galvanized** Steel Pipe should be maintained "dry" (free of water). Dissolved oxygen (main cause) and carbon dioxide in water can increase corrosion rates for galvanized steel pipe (with zinc then steel corrosion). It should be noted that new dry or preaction systems can develop through-wall corrosion pinhole leakage from 2 to 3 years after initial installation due to residual water causing corrosion in **galvanized** steel pipe.

US Department of Defense Fire Code UFC 3-600-01 (March 2018)

- 9-7.6.1.1 – **Galvanized** piping is only permitted for deluge sprinkler systems, valve trim and drain piping exposed to the *Facility* exterior.
- 9-7.6.1.2 – Black steel pipe must be used for the addition, repair or relocation of existing galvanized pipe in wet, dry pipe or preaction systems.

US Government Services Administration Fire Code PBS-P100 (April 2017)

- 7.8.2 – **Galvanized** (internal and external) sprinkler piping is not permitted to be used for dry pipe sprinkler systems.

Engineered Corrosion Solutions Recommendations (April 2018)

New Construction

- Never use **galvanized** steel piping for wet pipe fire sprinkler systems.
- If **galvanized** steel piping is used for dry and preaction systems, then an FM Approved nitrogen generator must be used for pressure maintenance to prevent oxygen corrosion.
- **Galvanized** steel piping can be used in deluge systems if special care is taken to eliminate standing pools of water within the piping (pitch and auxiliary drains).

Remediation of Existing Systems

- Black steel pipe must be used for any addition, repair, replacement, relocation of existing **galvanized** steel pipe in wet, dry or preaction system.
- Wet Pipe Nitrogen Inerting (WPNI) must be used to stop ongoing corrosion in any **galvanized** steel or black steel wet pipe system that is experiencing corrosion related leaks.
- Dry Pipe Nitrogen Inerting (DPNI) using an FM Approved nitrogen generator for pressure maintenance must be used to prevent oxygen corrosion in any **galvanized** steel or black steel dry or preaction system.

Conclusions

Within the fire protection industry there is persistent confusion about when and under what conditions galvanized steel piping should be used. Many continue to believe that galvanized steel pipe provides better corrosion protection in fire sprinkler piping installations. Many continue to believe that it is “required”.

It is clear, under persistently moist conditions with oxygen present, galvanized steel corrodes much faster than black steel and will develop leaks. Galvanized steel pipe also costs about 30% more than black steel pipe. The corrosion process also causes galvanized steel piping to shed Zn^{2+} ions into the discharge water when dry and preaction systems are tested. This creates a heavy metal contamination environmental hazard. Many municipalities prohibit discharges of water containing more than 30 mg/L of Zn^{2+}. Most discharged water from galvanized dry and preaction fire sprinkler systems contain 1000+ mg/L of Zn^{2+}.

ECS Engineered Corrosion Solutions
ecscorrosion.com

Using galvanized steel piping in garden centers, parking structures, stadiums and under outdoor canopies makes sense to protect the external piping from corrosion without having to paint the piping. However, in this application an FM Approved nitrogen generator must be used to protect the internal surfaces from aggressive oxygen corrosion where moisture collects. Nitrogen generators provide non-corrosive inert gas for pressure maintenance and the gas has a dew point of less than -50°F, so it does not add condensate moisture. An added benefit is that drum drips do not need to be worked regularly to remove condensate moisture.

With the evolving knowledge regarding the vulnerability of galvanized steel to oxygen corrosion galvanized steel sprinkler piping is becoming more prohibited than required.

References

[1] National Association of Corrosion Engineers (NACE) Resource Library on Materials Selection - Zinc

[2] FM Global Property Loss Prevention Data Sheet 2-1 "Corrosion in Automatic Sprinkler Systems" October 2017.

Engineered Corrosion Solutions, LLC is a corrosion management consulting firm that offers fire sprinkler system assessment and analysis coupled with design services and a full suite of corrosion management strategies that include equipment and integrated devices for controlling corrosion in water-based wet, dry, and preaction fire sprinkler systems. We understand the science of corrosion in fire sprinkler systems in a complete variety of different settings from parking structures to warehouses to clean rooms to data centers.

Engineered Corrosion Solutions, LLC offers proprietary dry pipe nitrogen inerting technology (DPNI) and wet pipe nitrogen inerting technology (WPNI), which includes the ECS Protector Nitrogen Generator, Pre-Engineered Skid Mounted Nitrogen Generator, Gas Analyzers, SMART Dry Vent, Two (2) Wet Pipe Nitrogen Inerting Vents and the industry's first real time in-situ corrosion monitoring device the ECS In-Line Corrosion Detector. Finally, we offer the first comprehensive remote corrosion monitoring system that provides live validation of the corrosion control strategy that is in place within your facility.

For complete information about the entire line of corrosion management products and services and the complete list of downloads of White Papers, FAQs, installation schematics and product spec sheets please visit the Engineered Corrosion Solutions website at ecscorrosion.com or contact us at (314) 432-1377 and one of our engineers will assist in personally answering any of your questions.

ECS Engineered Corrosion Solutions
ecscorrosion.com