Engineered Corrosion Solutions™

Complete Corrosion Control.

Nitrogen Inerting For Corrosion Control in Fire Sprinkler Systems

Presented by:
Lucas Kirn, PE
Engineered Corrosion Solutions

Fire Sprinkler Industry Conventional Wisdom

Corrosion is considered ***normal*** and ***unavoidable.***

Root causes are not well understood and ***myths abound*** . . .
No corrosion engineers!

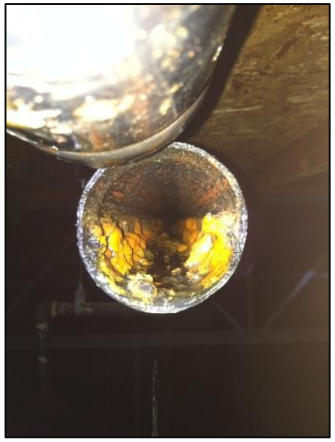
Current practice involves continually repairing leaks and completely replacing fire sprinkler systems.

Insanity – Continuing to do the same thing and expecting different results!

Fire Sprinkler Industry

Question: How common is corrosion?

Answer: Virtually all water based fire sprinkler systems are subject to attack by **oxygen corrosion**.



It is everywhere!

Fire Sprinkler Corrosion
The Industry Myths

No.1 – MIC, MIC, MIC

No.2 – Bad Water

No.3 – Bad Pipe

No.4 – Galvanized steel is better than black steel

No.5 – Material defect causes weld seam failures

No.6 – Systems with high leak frequency - replace

Corrosion in Water Based FPS

Engineered Corrosion Solutions
Complete Corrosion Control.

Factors that Accelerate Corrosion Failures

- More O_2 = More Corrosion
- Dry pipe fail faster than wet pipe
- Galvanized fail much faster than black
- Level of activity (drain/fill, remodels)
- System design – trapped air/water
- Quality of the system installation
- Higher temperatures increase rate

In every instance

Leak repair process creates more leaks

Corrosion in Water Based FPS

Engineered Corrosion Solutions
Complete Corrosion Control.

Average service life of fire sprinkler systems today

- **Wet pipe systems** – 15 – 25 years with an average corrosion rate of 5 to 10 mils per year; failures generally start occurring after 15 years

- **Dry pipe systems** – 10 – 15 years with an average corrosion rate of 10 to 20 mils per year; failures start occurring in less than 5 years; galvanized systems have failed in 12 months

What Are The Corrosion Risks?

Engineered Corrosion Solutions
Complete Corrosion Control.

Risks Associated with FPS that Do Not Work

- Life Safety Risk
- Structure and Property Risk

Fire Marshal's Concerns

Risks Associated with Leaking FPS

- Repair and Replacement Cost - $
- Structure and Property Risk - $$
- Business Continuity Risk - $$$$

Property Owner Concerns

Engineered Corrosion Solutions
Complete Corrosion Control.

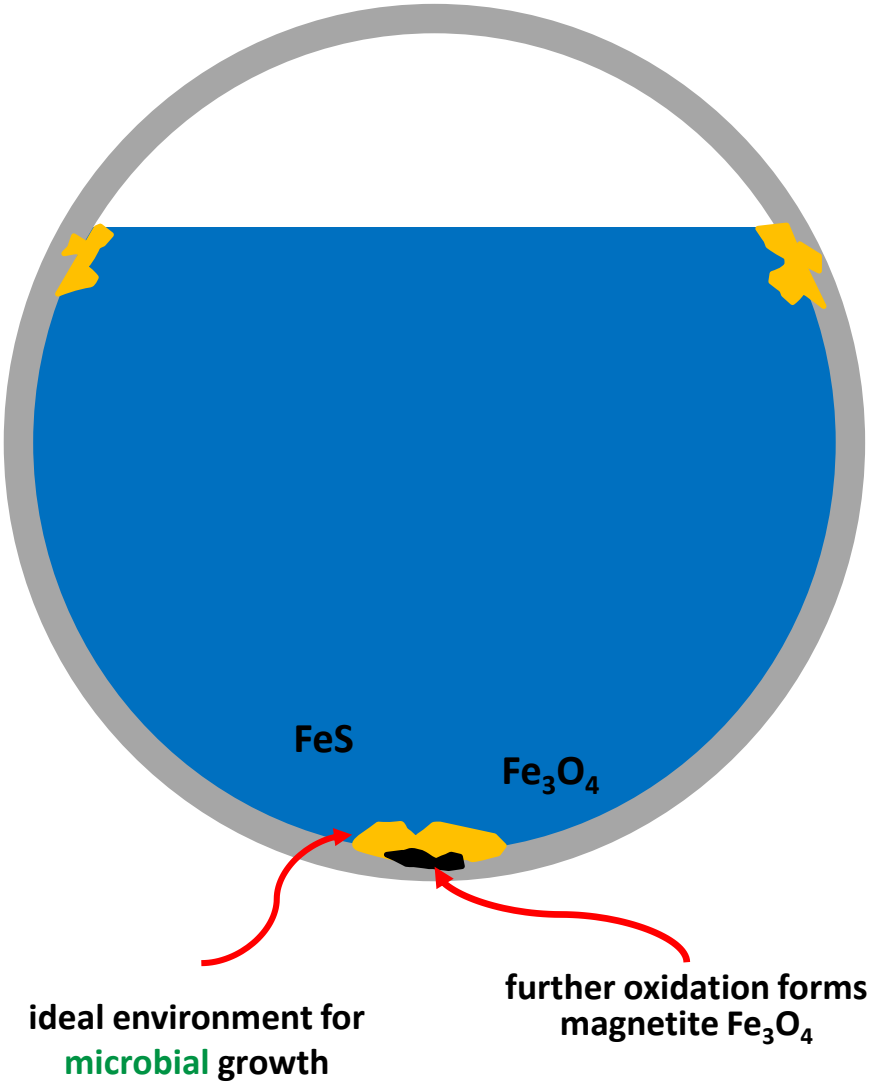
When Complete Systems Are Replaced?

We find that 80% of the piping shows no significant corrosion.

The Most Expensive Approach?

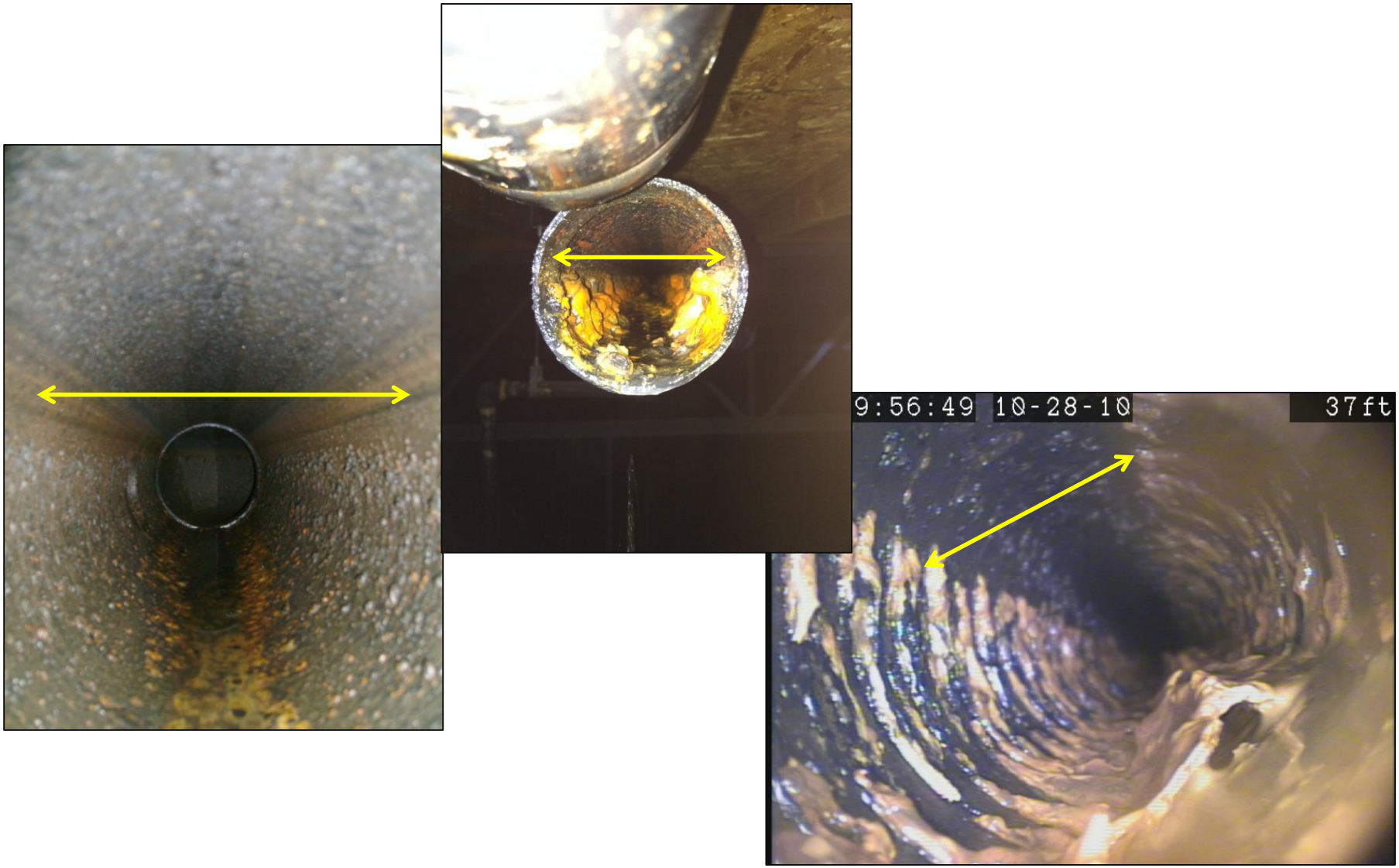
Replacing the fire sprinkler system one leak at a time!

Wet Pipe System Internal Corrosion



- Iron from the interior pipe wall reacts with oxygen and dissolves into the water
- Reaction forms hematite (Fe_2O_3)
- As iron is shed from interior pipe wall it leaves a void or pit at the air/water interface
- Oxygen in water drives the reaction until all available oxygen is consumed
- Iron oxide collects at “bottom” of pipe activating under deposit corrosion mechanisms
- Creates ideal environment for bacteria (MIC)
- Further oxidation forms magnetite (Fe_3O_4)

In Wet Systems Look for the Trapped Air



What Does Wet Pipe Fire Sprinkler Systems Corrosion Look Like?

Engineered Corrosion Solutions
Complete Corrosion Control.

Metal Loss Due to Corrosion

Engineered Corrosion Solutions
Complete Corrosion Control.

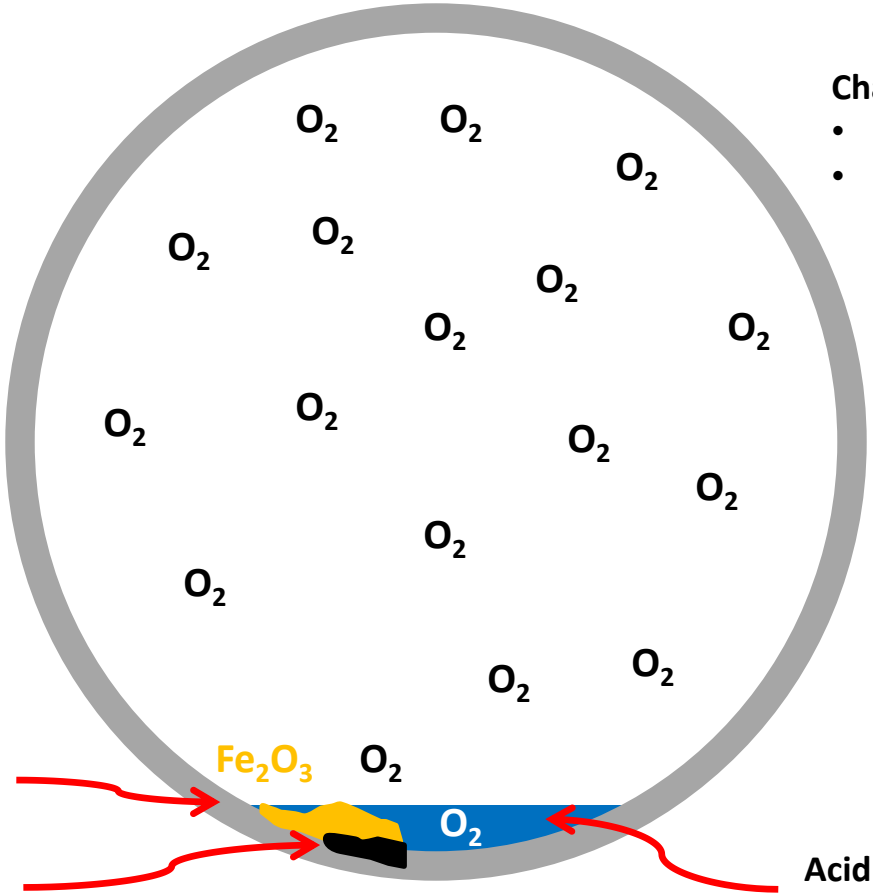
Dry and Preaction Fire Sprinkler Corrosion

Engineered Corrosion Solutions
Complete Corrosion Control.

- Corrosion localized at locations in piping with **trapped water**
- Much **more oxygen available** per wetted pipe surface area
- Compressor continuously add **warm, moist oxygen**
- Condensate water from compressor **very acidic**
- **Dryers ineffective** in preventing corrosion

Dry and Preaction Fire Sprinkler System Corrosion

Engineered Corrosion Solutions
Complete Corrosion Control.



Characterized by

- **excessive amounts of oxygen**
- **wetted metal corrodes very quickly**

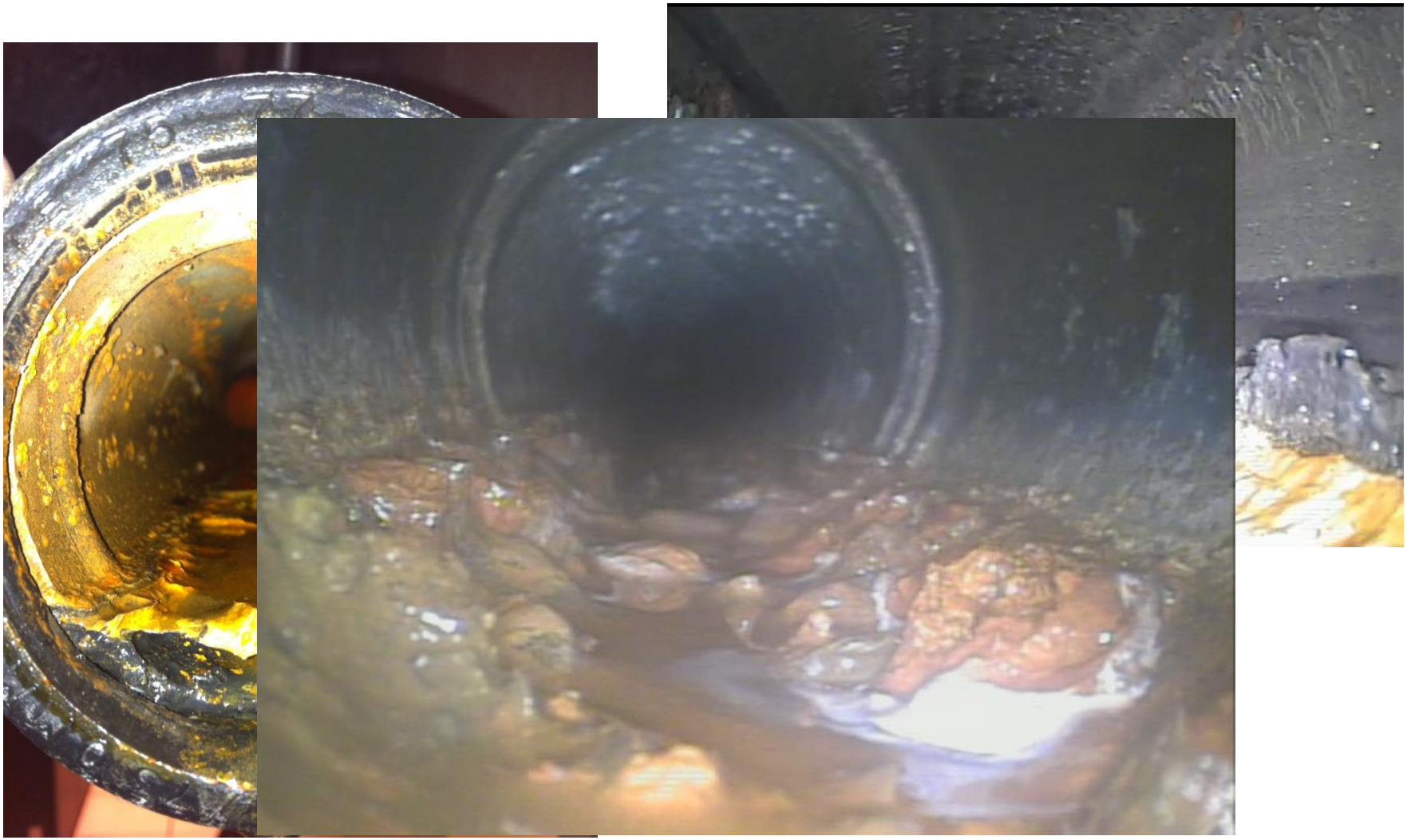
First forms hematite

Oxygen depleted area then forms magnetite

Acidic condensate forms carbonic acid pH around 5.5

In Dry Systems Look for the Trapped Water

Engineered Corrosion Solutions
Complete Corrosion Control.



Galvanized Pipe in Dry/Preaction FPS

Engineered Corrosion Solutions
Complete Corrosion Control.

Why Use Galvanized Pipe?

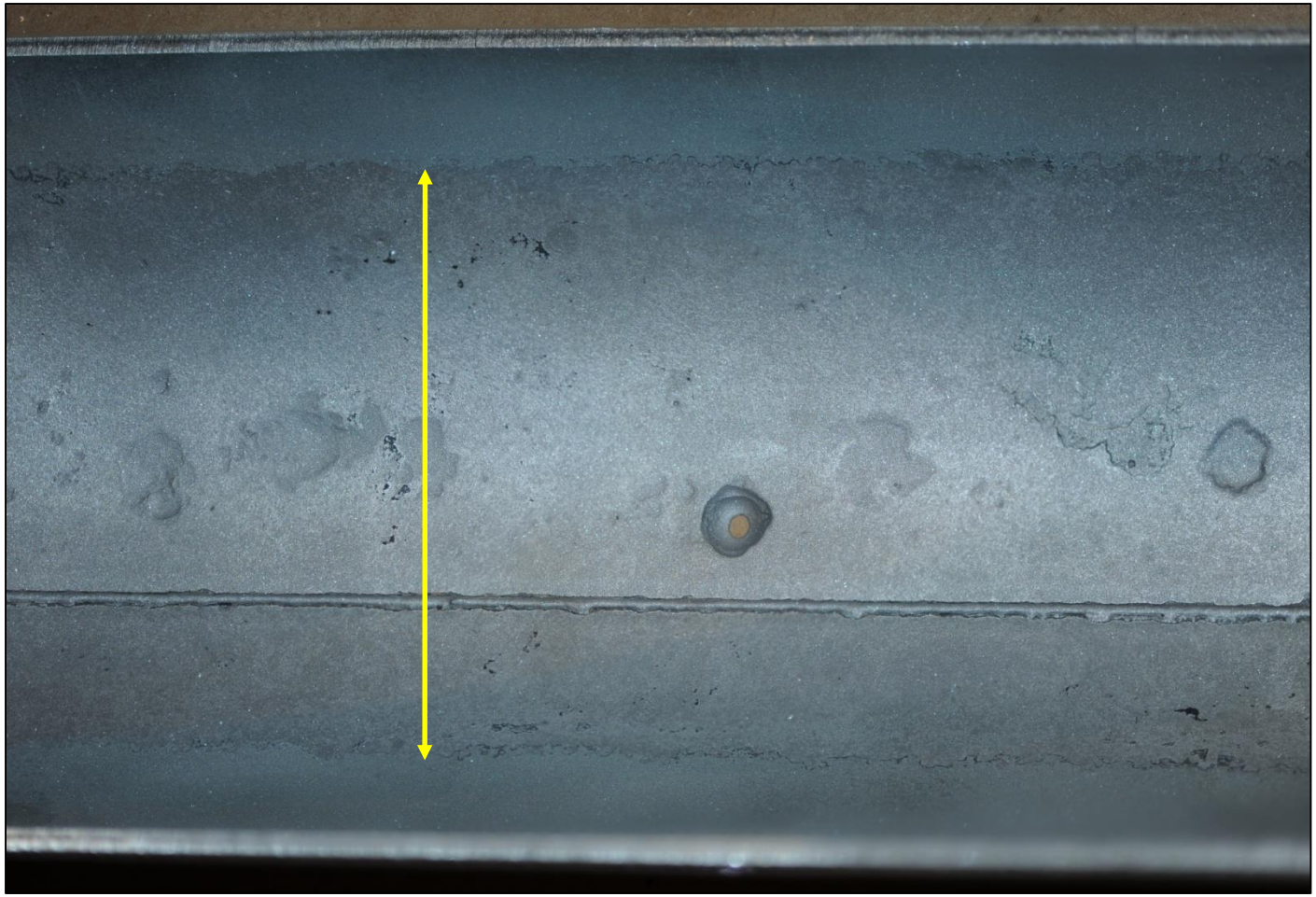
- **Primary** means of protection is zinc coating
- **Secondary** protection is cathodic protection of iron by zinc

In a persistently **moist oxygenated environment** galvanized pipe will fail 3 - 4 times faster than mild steel – highly localized attack

When Galvanized Pipe is Used …

Engineered Corrosion Solutions
Complete Corrosion Control.

Galvanized Pipe Corrosion



Options for Controlling Corrosion

Engineered Corrosion Solutions
Complete Corrosion Control.

1. **Metallurgy** – too expensive
2. **Plastics** – restricted by code
3. **Coatings** – delamination complications
4. **Chemical Inhibitors** – ineffective, incompatible
5. **Remove the Corrosive Gas** – purge the oxygen

Wet Pipe Nitrogen Inerting (WPNI) Process

(patent pending)

Engineered Corrosion Solutions
Complete Corrosion Control.

Three essential components for the WPNI process:

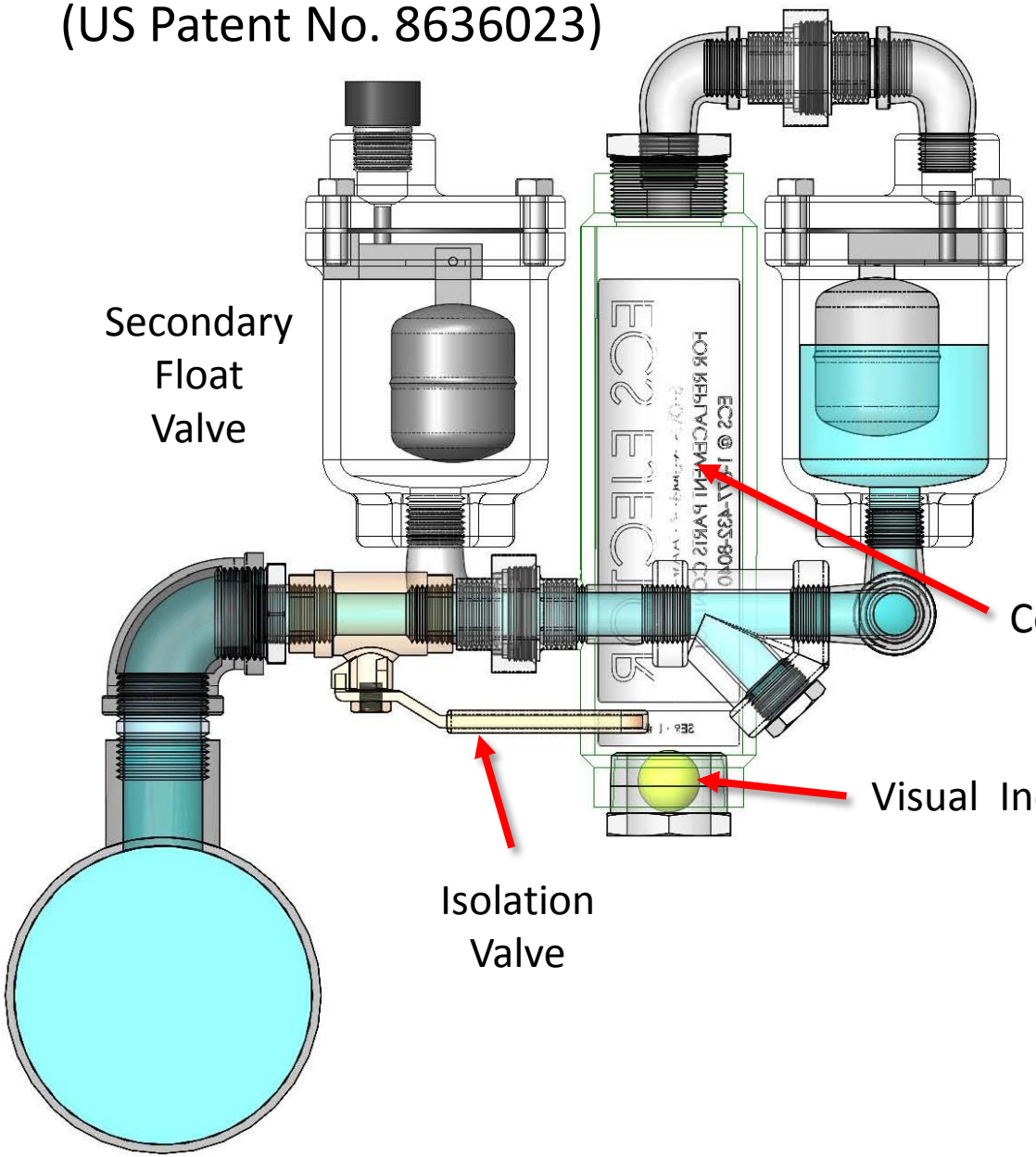
1. **Integral venting device** to facilitate removal of oxygen from the system piping

2. **Source of nitrogen gas** of 98%+ purity (cylinders or nitrogen generator)

3. **Nitrogen injection port** to perform the “fill and purge” breathing process on the system piping in conjunction with the integral venting device

Integral Venting Device

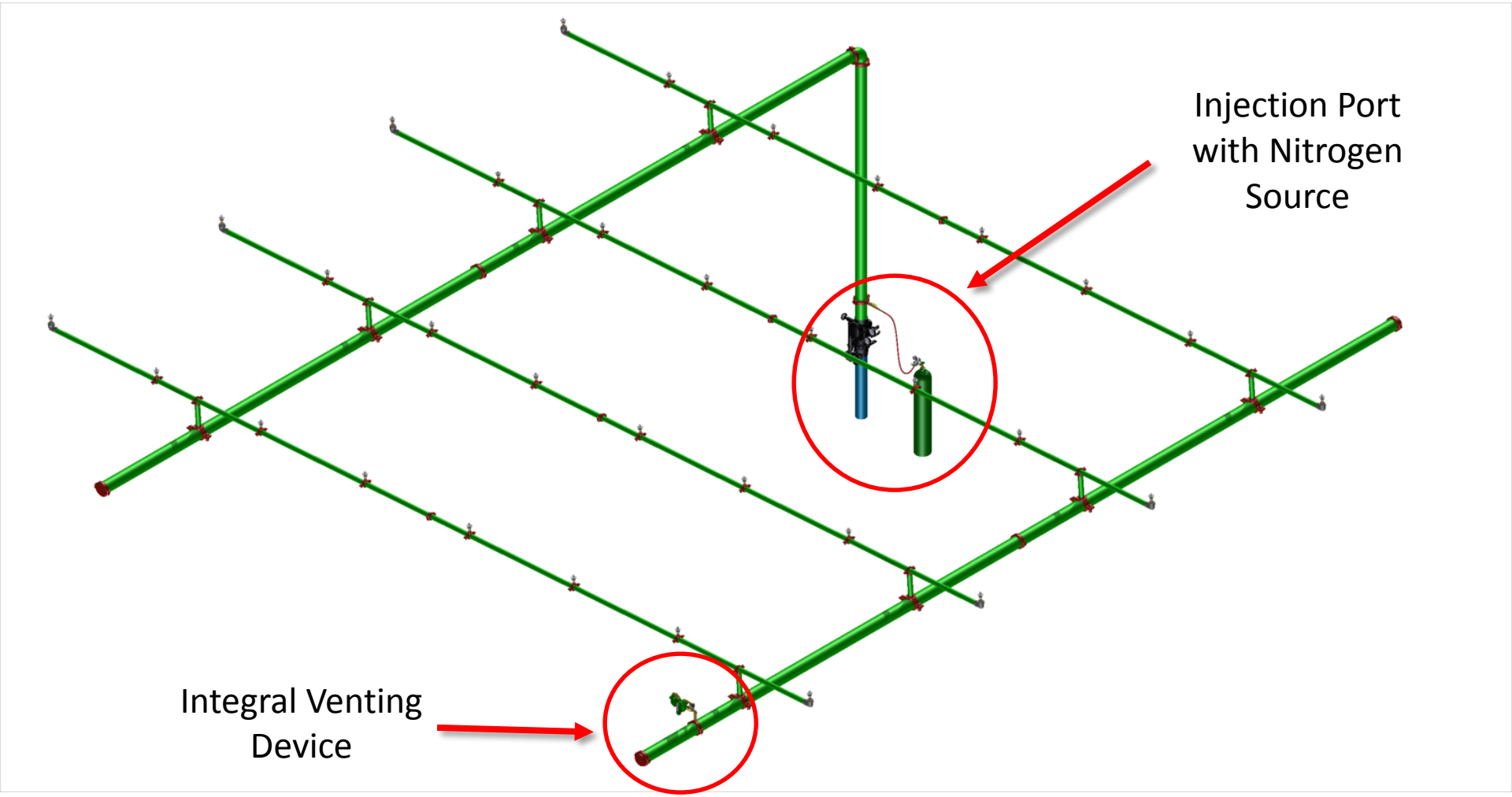
(US Patent No. 8636023)



Typical Wet Pipe Installation

(Patent Pending)

Engineered Corrosion Solutions
Complete Corrosion Control.



Dry Pipe Nitrogen Inerting (DPNI) Process

(patent pending)

Engineered Corrosion Solutions™

Complete Corrosion Control.

Three essential components for the DPNI process:

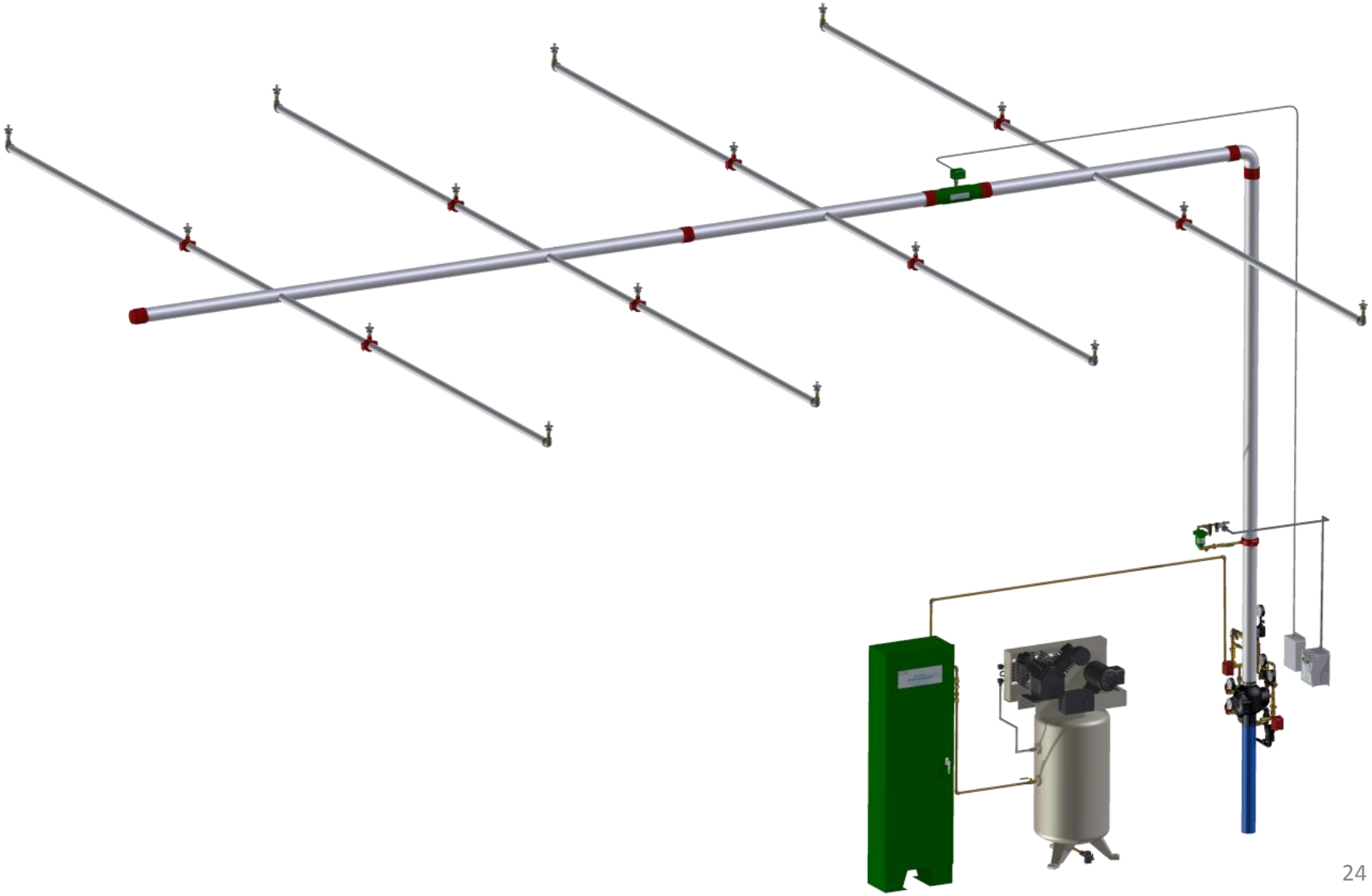
1. **Continuous source** of nitrogen gas of 98%+ purity

2. **Integral venting device** to facilitate removal of oxygen from the dry/preaction piping

3. **Breathing system** to perform the pneumatic “fill and purge” breathing process in conjunction with the nitrogen generator and the integral venting device

Typical Dry Pipe Installation

(Stand-Alone Generator System - patent pending)



Corrosion Monitoring

Engineered Corrosion Solutions
Complete Corrosion Control.

How Does the Industry Monitor Corrosion Today?

- Wait for the first leak to occur
- Riser mounted coupons

Why Monitor Corrosion in Fire Sprinkler Systems?

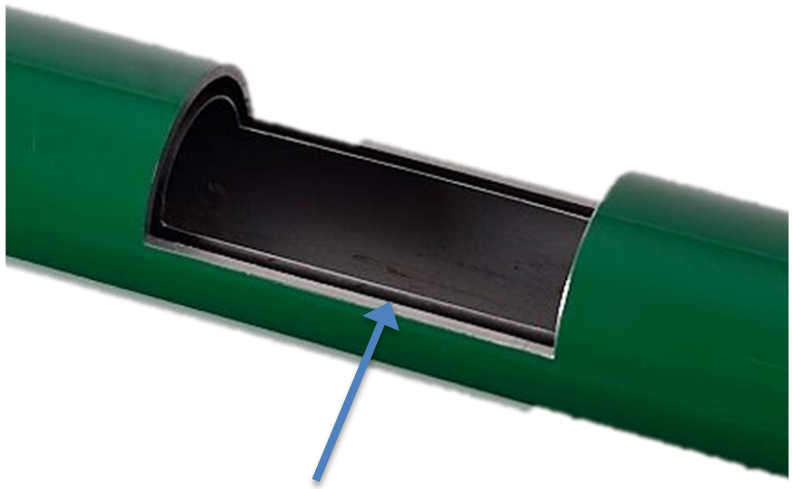
- Early warning system to prevent risk
- Validate effectiveness of corrosion management system

ECS In-Line Corrosion Detector

(Patent Pending)

ECS In-Line Corrosion Detector

(Patent Pending)



results in thin walled section 25 mils thick, surrounded by sleeve that creates a pressure chamber

milled section of pipe

Remote Test Station included

NFPA 13 Installation Standard

2013 Edition

Engineered Corrosion Solutions
Complete Corrosion Control.

24.1.5.3

Where listed biocides and/or corrosion inhibitors are used, they shall be compatible with system components. Where used together, they shall also be compatible with each other.

There are currently ZERO biocides/corrosion inhibitors listed for use in FPS.

Table 23.4.4.7.1 Hazen-Williams *C* Values

- Black Steel (dry systems including preaction) 100
- Black Steel (wet systems including deluge) 120
- Galvanized Steel (dry systems including preaction) 100
- Galvanized Steel (wet systems including deluge) 120

There is NO hydraulic advantage to using galvanized pipe.

CONCLUSIONS

- The root cause for corrosion in water based fire sprinkler systems is **OXYGEN**
- Removing the corrosive gas is the most cost effective method of eliminating corrosion in fire sprinkler systems
- The use of Nitrogen gas to displace oxygen is quickly growing in acceptance industry wide
- An effective means of corrosion monitoring should be employed with any corrosion management system