Corrosion Inspection & Repair Solutions for Water Systems

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Corrosion
Temporary Fix?
Corrosion - A Natural Process

IRON OXIDE + REFINING + MILLING = IRON, STEEL, PCCP

IRON, STEEL, PCCP + CORROSION = IRON OXIDE
Corrosion of Metallic Structure
History of Iron Pipe

Cast Iron
- Introduced to North America during the 1800’s.
- Statically cast process produced a thick walled, heavy pipe.

Ductile Iron
- Introduced in 1955 as an improvement to cast iron.
- Centrifugal casting process produces a thinner walled, lighter pipe which is stronger and more ductile than cast iron.
Actual size of AWWA Specification Thickness Reductions for 36-inch Diameter Cast and Ductile Iron Pipe - 1908 to Present (150 PSI Operating pressure)
Cast (Grey) Iron Failures

Graphitization leaves pipe brittle and weakened.
Ductile Iron

Pitting (concentrated) corrosion attack on ductile iron pipe.
Adverse Conditions for Metallic Pipe

- High Chlorides
- Low Soil/Water Resistivity
- High Sulfates
- Acidic Soils
- Wet/Dry Fluctuations
- Bimetallic Couplings
- Stray Current Interference
Cathodic Protection

Rectifier

Anode Groundbed

Gas Pipeline

(-) Cathodic Protection Rectifier

(+) Anode Groundbed

Current Discharge (Corrosion)

Water Pipeline

Current Discharge (Corrosion)

Stray Current Due to Impressed Current Cathodic Protection System
Impressed Current CP System on Oil/Gas Lines can Create Stray Current Problem on Water Lines
Stray Current
Bonding Across a Bell and Spigot or Slip-joint

Thermite brazed connection coated with bitumous compound

Copper wire with direct burial insulation
Follow manufacture’s and AWWA recommendations to insure proper installation of polyethylene encasement.

In extremely corrosive areas, additional methods (bonding of joints, cathodic protection, may be required).
Pipeline Inspection Report

Inspector name_________              Date____            Address of pipeline inspection ________________     Leak?   Yes____ No_ ___    File Number:_____________

1) Type of Pipe:  cast iron_____    ductile iron____  carbon steel___   copper______ carbon steel_____ non metallic_____ other____
2) Diameter of pipe _____”   Pipeline Name_________ Service Type: Water____ Wastewater____   Estimated date of pipe installation______ Depth of pipe______’
3) Type of Pipe: Distribution____   Transmission_____  Service_____   Hydrant_____ Mechanical joint_____ Fasteners_____ Other____ Unknown____
4) Type of Coating:   Polyethylene Encased____  Shop applied coating___ No Coating____ Tape Wrap____ Unable to determine____
5) External Pipe Condition:  Very Good____ Good____ Poor____ comments:___________________________________________________________________________________________

6) Is corrosion pitting evident? ____ Yes ___ No         Number of Pits______             Typical Size of Pits______      Quantity of pits:____
7) Is graphitization evident (longitudinal or circumferential breaks) ____Yes ____ No
8) Is the pipe installed in (check off appropriate items):  Industrial area____   Residential area_____ Rural area_____ Near street or road ____
   Near creek or waterway _____ In reclaimed land____ Near oil or gas pipelines_____ Near high voltage lines____.
8) Describe soil conditions  where inspection occurred:  wet____ dry____ clay soil ____ rocky soil____ cinders____ other____________________
9) Where soil samples obtained, sealed and analyzed for chlorides, moisture content, pH, sulfides, resistivity? If yes results were: _____________________________
10) Were previous repairs made on the pipeline (leak clamps, etc) Yes____  No ____. Was new pipe installed____ Yes ____ No.
11) Was a repair clamp installed on the pipe during inspection ___ Yes  ___ No
12) Was a galvanic anode installed as part of the inspection process?  ___ Yes ___ No, if yes size and quantity
13) Digital Photos

![Digital Photos](image1.png) ![Digital Photos](image2.png) ![Digital Photos](image3.png)
Investigative Structure (Existing)

Corrosion Assessment
- Review of General Characteristics of Water System
  - Age
  - Material Type
  - Wall Thickness
  - Construction Practices
- Review Break / Leak History
- Field Survey
  - Soil Conditions (Resistivity, Moisture Content, Chemical Analysis)
  - Electrical Test
- Data Analysis & Risk Management
- Priority Index (Identification of Opportunities to Reduce Replacement / Repair Costs)
## PRACTICAL GALVANIC SERIES

<table>
<thead>
<tr>
<th>Material</th>
<th>Potential*</th>
<th>Corrosiveness</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pure Magnesium</td>
<td>-1.75</td>
<td>Corrosive</td>
</tr>
<tr>
<td>Zinc</td>
<td>-1.10</td>
<td></td>
</tr>
<tr>
<td>Aluminum Alloy</td>
<td>-1.00</td>
<td></td>
</tr>
<tr>
<td>Cadmium</td>
<td>-0.80</td>
<td></td>
</tr>
<tr>
<td>Mild Steel (New)</td>
<td>-0.70</td>
<td></td>
</tr>
<tr>
<td>Mild Steel (Old)</td>
<td>-0.50</td>
<td></td>
</tr>
<tr>
<td>Cast/Ductile Iron</td>
<td>-0.50</td>
<td></td>
</tr>
<tr>
<td>Stainless Steel</td>
<td>-0.50 to +0.10</td>
<td></td>
</tr>
<tr>
<td>Copper, Brass, Bronze</td>
<td>-0.20</td>
<td></td>
</tr>
<tr>
<td>Gold</td>
<td>+0.20</td>
<td></td>
</tr>
<tr>
<td>Carbon, Graphite, Coke</td>
<td>+0.30</td>
<td>Less Corrosive</td>
</tr>
</tbody>
</table>

*Potentials With Respect to Saturated Cu-CuSO₄ Electrode*
Coupling to Dissimilar Metals

Metallic Connection

Copper service (Cathode) - 300mV

Iron pipe (Anode) - 500mV
Anode Installation Prevents Corrosion on Copper Service Line

- Non metallic or Polyethylene Encased Ductile Iron Main
- Anode Connection to Line
- Anode
Meter Vaults

(Keep dry if possible)
Gate Valve Corrosion
Water Wells
Water (Electrolyte)

Anodic Area (Corrodes)

Metallic Return Path

Cathodic Area (Protected)

Tank Wall

Current Flow
Anode

Cathode (Protected)
CP for New or Refurbished Tanks
CP Benefits:
- Triple life of coating
- Reduce maintenance cost
Thermit Weld to Pipe
Anode Installation

Augered hole

Galvanic anode

Connection to piping
Break Records for Water Mains Cathodically Protected

Cathodic Protection Results
Length Protected = 55,360 feet

94 Breaks Prior to Cathodic Protection
1 Breaks After Cathodic Protection
Repair of Break Should Include Anode Installation

Incomplete

Complete
Water Leak Repair Kit

Includes:

Installation instructions.

One day onsite technical assistance.

Cathodic protection components/connection materials suitable for 10 repairs.
Pipe

Metallic Coupling

Lower Stress Area (Cathode)

Threaded Bolt
Higher Stress Area (Anode)

Stress Corrosion

Metallic Coupling
Pipe

Metallic Coupling

Galvanic Anode

Anode Lead Wire Connection

Cathodic Protection of Metallic Fitting
Anode Installed on Metallic Fitting
Pumping Stations
Depleted & Refurbished Cathodic Protection for Lift Stations

Depleted cathodic protection system allows corrosion to occur.

Effective cathodic protection system prevents corrosion and extends life of lift station.
Corrosion of Clarifier Center Well
AC Mitigation
Internal Corrosion of Force Mains....
24” Ductile Iron Force Main

- Internal failure following loss of internal mortar lining
- Failure was along top of pipe due to formation of hydrogen sulfide gas
Insituform
Traffic Disruptions
Water Loss
Fire Protection
Damages
Legal & Environmental Claims
QUESTIONS?

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