Cathodic Protection for Buried Copper Piping and 100 mV Polarization Shift

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Outline

- **1.** Current Practices
- 2. Code References
- 3. 100 mV Shift
- 4. Other Considerations

Copper line protection What do we see?

- Unprotected bare copper
- Unprotected coated copper



- Protected by tank anodes (not isolated)
- Spike anodes









Spike Anode



Code References



Code references:

- 49 CFR 192.455 (External Corrosion Control) buried lines installed after July 31, 1971 must be coated <u>and</u> cathodically protected
- NFPA 58 handbook refers to NACE RP-01-69
 - §1.2.1: New piping systems CP should be provided
 - §1.2.2: Existing coated systems CP should be provided

Code references:

- 49 CFR 192.463 CP must be in compliance with Appendix D
- 49 CFR 192 Appendix D, Part I, Subpart C Must evaluate CP for copper facilities using *polarization voltage shift of* 100 mV
 - Only criterion for copper pipe
 - Exception for dissimilar metals cathodically protected as a single system

100 mV shift

$$\int_{a}^{b} f(x) - g(x) \, dx \quad \text{or} \quad \int_{a}^{b} f(y) - g(y) \, dy$$

$$y = g(x)$$

$$y = g(x)$$

$$y = f(x)$$

$$y = f(x)$$

$$y = f(x)$$

$$y = f(x)$$

$$y = f(x) - g(x) \, dx$$
Blue:
$$\int_{a}^{k} g(x) - f(x) \, dx$$
where k is an intersection between $f(x)$ and $g(x)$

100 mV shift (from 49 CFR 192, Appendix D, III)

The polarization voltage shift must be determined by interrupting the protective current and measuring the polarization decay. When the current is initially interrupted, an immediate voltage shift occurs. The voltage reading after the immediate shift must be used as the base reading from which to measure polarization decay...

Equipment Needed

• Cu/CuSO₄ reference cell with voltmeter

 Current interruptor (for impressed current systems – galvanic systems can just be disconnected)





100 mV Polarization Decay



-720 mV – -580 mV = 140 mV polarization shift (adequate)

Combined metal systems

Appendix D, Part I, Subpart D negative voltage...equal to that required for the most anodic metal in the system must be maintained.

- Below grade steel tank with CP, if not isolated from below grade copper piping, may protect the piping
- If steel and copper are protected as part of the same system, the protective requirements for the steel should be sufficient to protect the copper piping
- CP readings must be taken over the length of protected piping
- Connecting copper piping may complicate steel tank protection and require installation of additional anodes

Galvanic Series of Metals

Practical Galvanic Series for Materials in Neutral Soils and Water

Material	Potential Volts (CSE) ^a
Carbon, Graphite, Coke	+0.3
Platinum	0 to -0.1
Mill Scale on Steel	-0.2
High Silicon Cast Iron	-0.2
Copper, Brass, Bronze	-0.2
Mild Steel in Concrete	-0.2
Lead	-0.5
Cast Iron (Not Graphitized)	-0.5
Mild Steel (Rusted)	-0.2 to -0.5
Mild Steel (Clean and Shiny)	-0.5 to -0.8
Commercially Pure Aluminum	-0.8
Aluminum Alloy (5% Zinc)	-1.05
Zinc	-1.1
Magnesium Alloy (6% Al, 3% Zn, 0.15% Mn)	-1.6
Commercially Pure Magnesium	-1.75

*Typical potential normally observed in neutral soils and water, measured with respect to copper sulfate reference electrode.

Another option:

 49 CFR 192.455(c) provides an exception – operator need not comply with CP requirements for copper lines *if it is demonstrated by tests, investigation, or experience that...a corrosive environment does not exist.*

and/but...

 49 CFR 192.455(d), though, includes a caveat – notwithstanding paragraph (c), if a pipeline is externally coated, it must be cathodically protected...

So what does this mean?

- In Maine, a qualified Maine-licensed engineer may provide the required demonstration that a corrosive environment does not exist, removing the requirement for cathodic protection on *bare copper* pipelines.
- Coated pipelines must be supplied with cathodic protection.
- Your state may have specific regulations pertaining to cathodic protection that exceed the federal minimum requirements.

Summary

- Copper pipe is typically very corrosion resistant.
- Below-grade copper pipe must be cathodically protected and coated.
- Bare copper pipe can be installed below grade without cathodic protection in soils that have proven not to be corrosive to copper by a licensed engineer.
- The only acceptable criteria for cathodic protection surveys for copper piping is the 100 mV shift method.

QUESTIONS?

