Active Corrosion Monitoring and AC Mitigation

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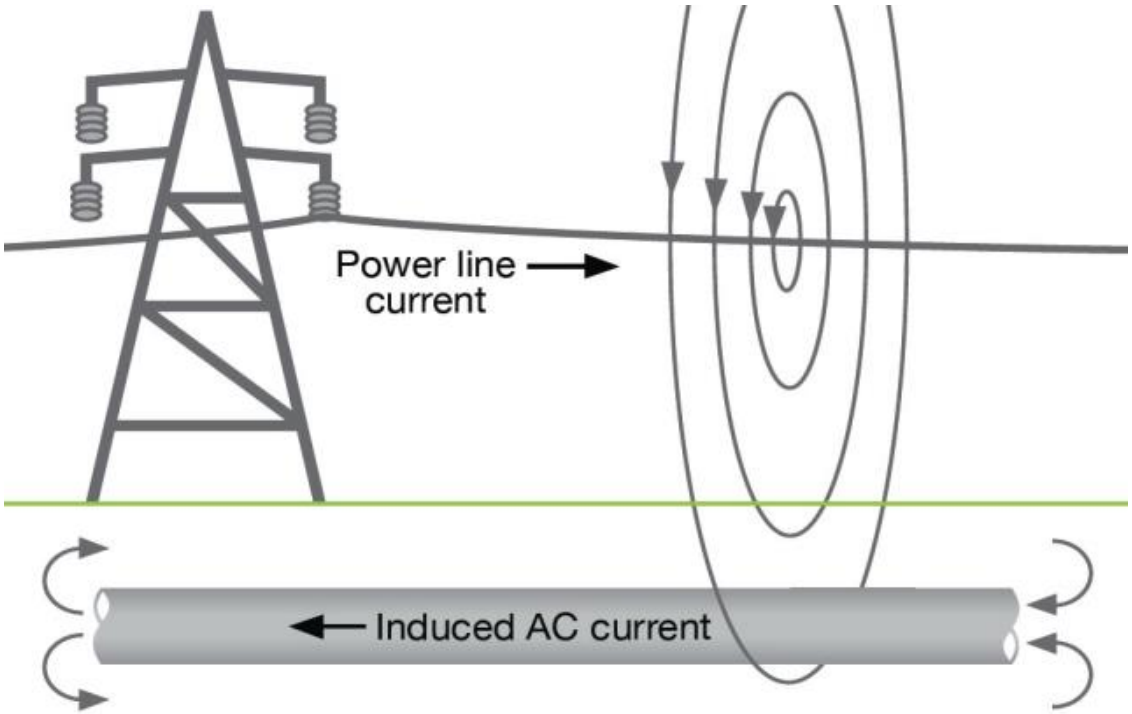
LG&E KU
PPL companies

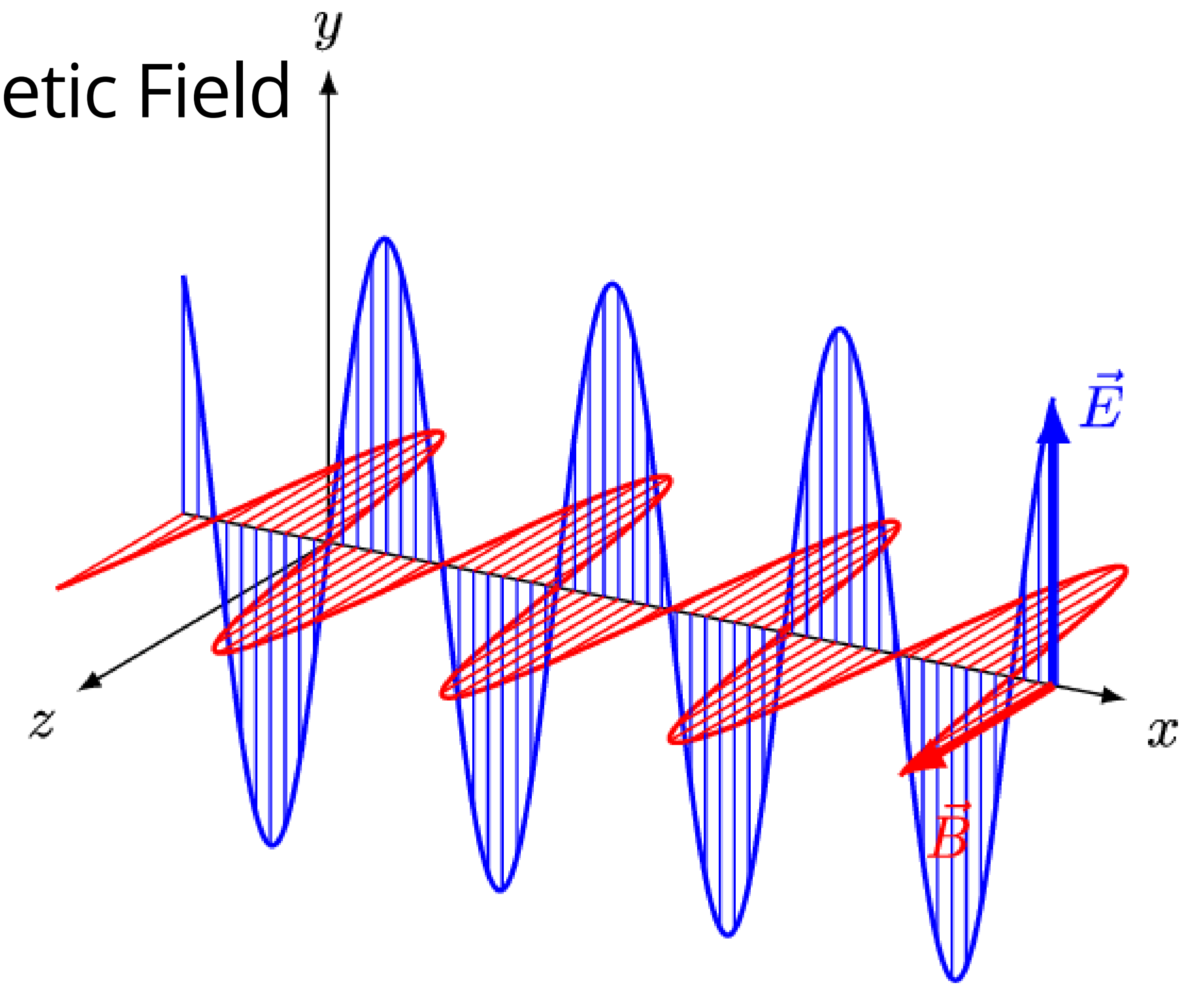
AC Interference

An interaction that occurs between high voltage power lines and steel pipelines in a common utility corridor

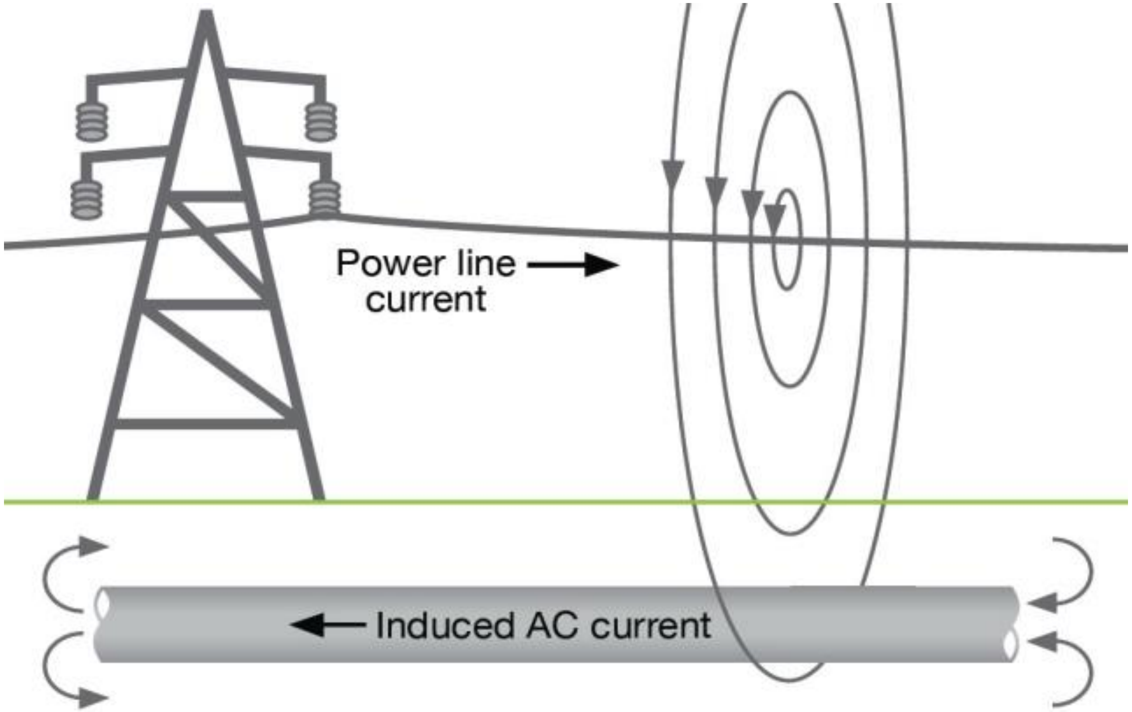


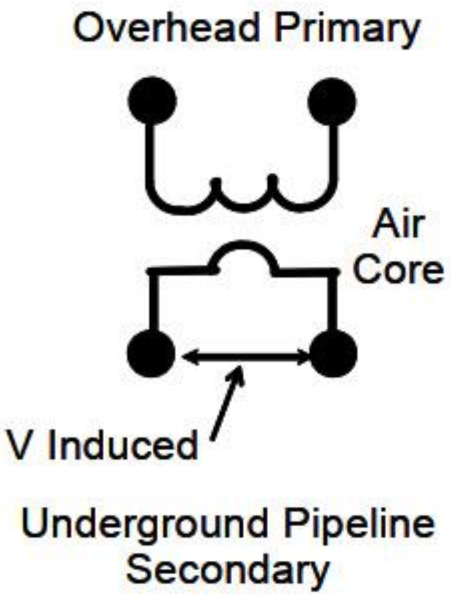
AC Interference

Electromagnetic Field

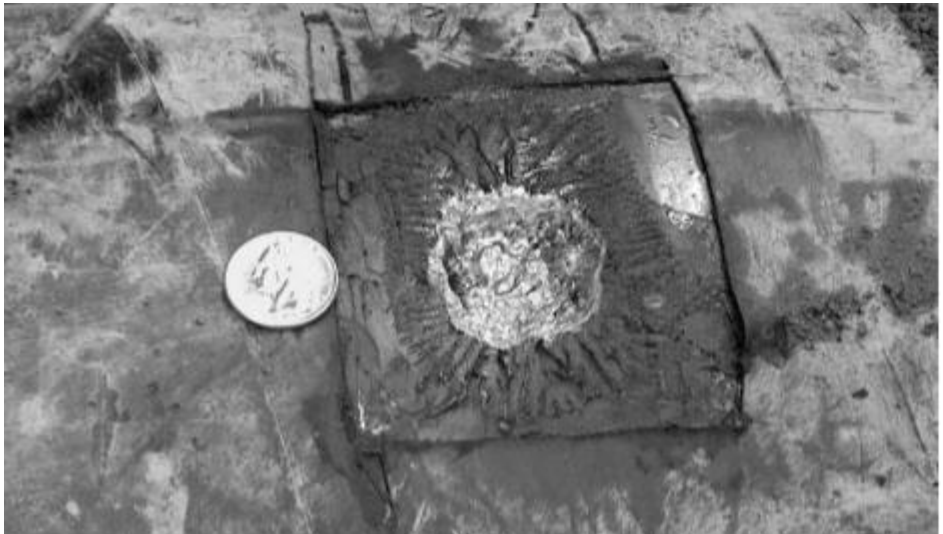


AC Interference





AC Corrosion



AC Corrosion

Rates of AC Corrosion are influenced by:

- If the pipeline overhead electric transmission line separate from one another at any point of collocation
- Holiday surface area

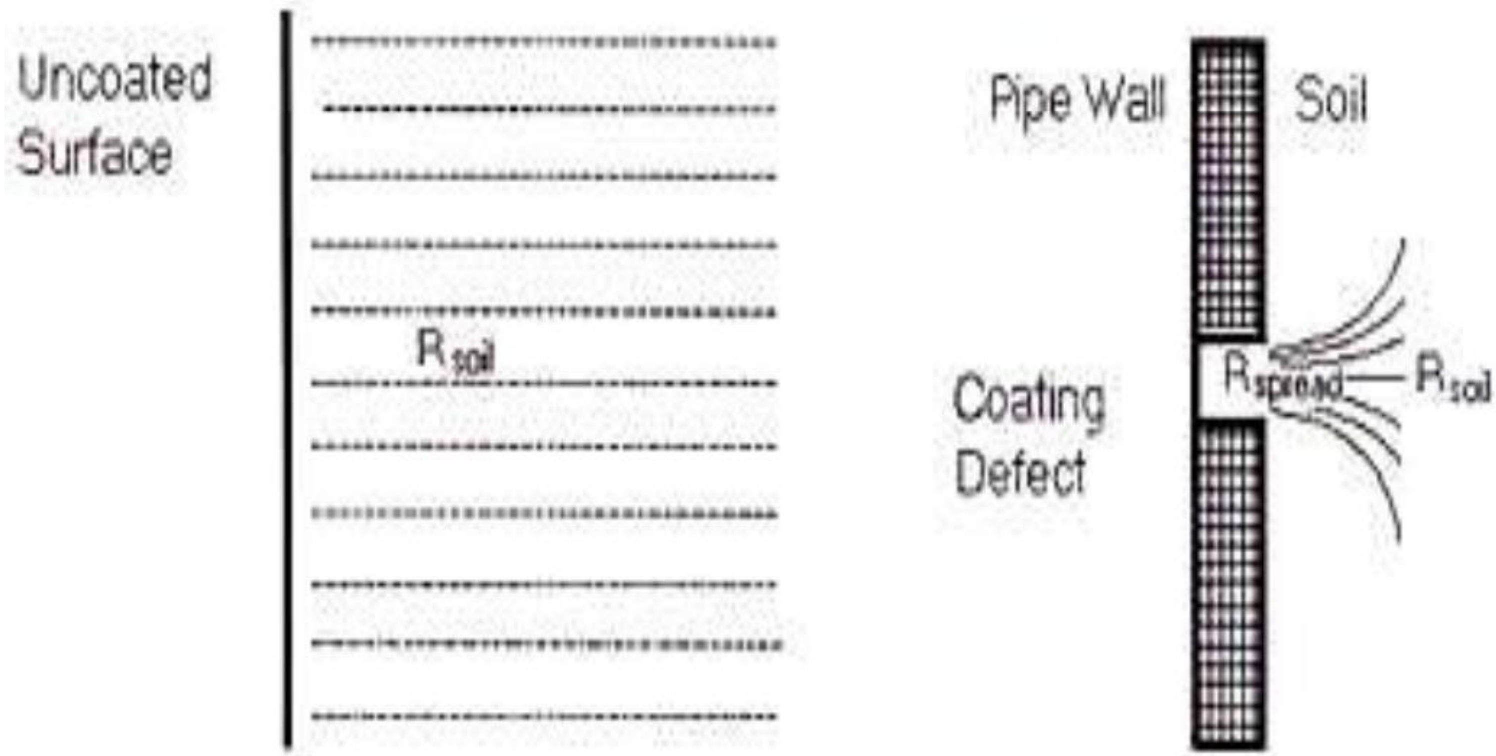
  Smaller holiday = greater risk of AC corrosion
- DC Current

  If DC current density is greater than 1 A/m^2, AC current density should not exceed 30 A/m^2

  If DC current density is less than 1 A/m^2, AC current density should not exceed 100 A/m^2

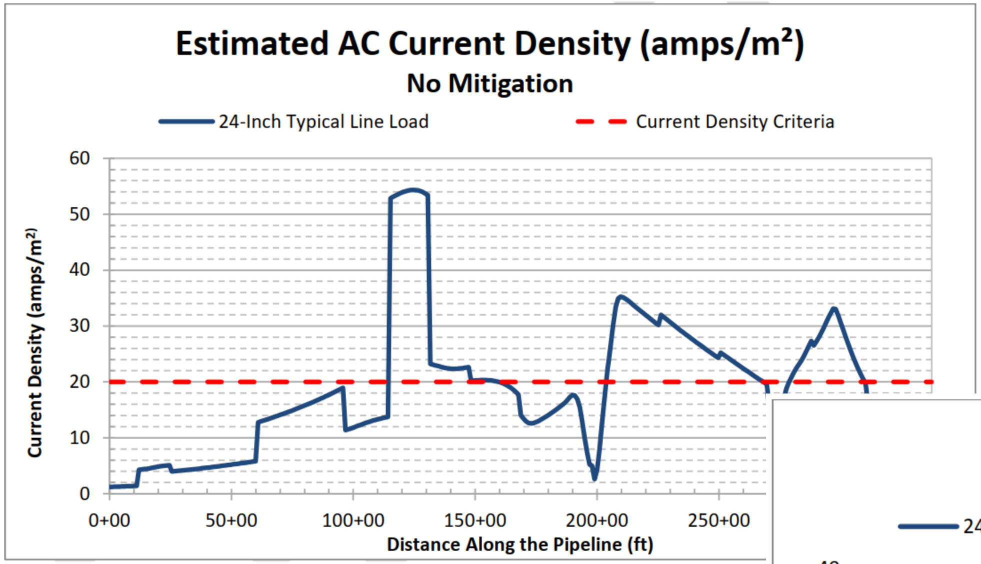
AC Corrosion

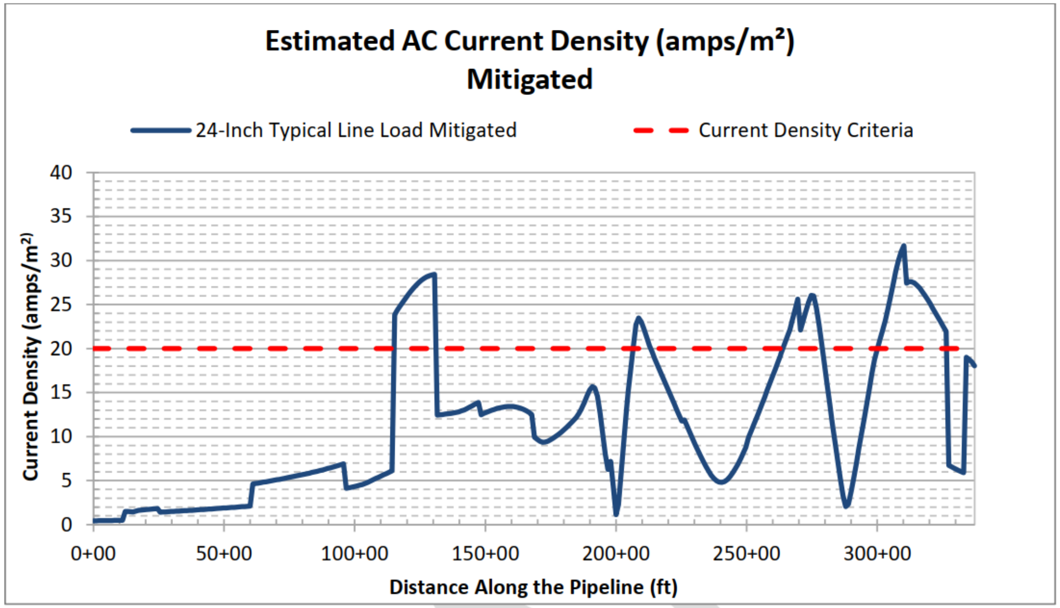
Spread Resistance (R_s)



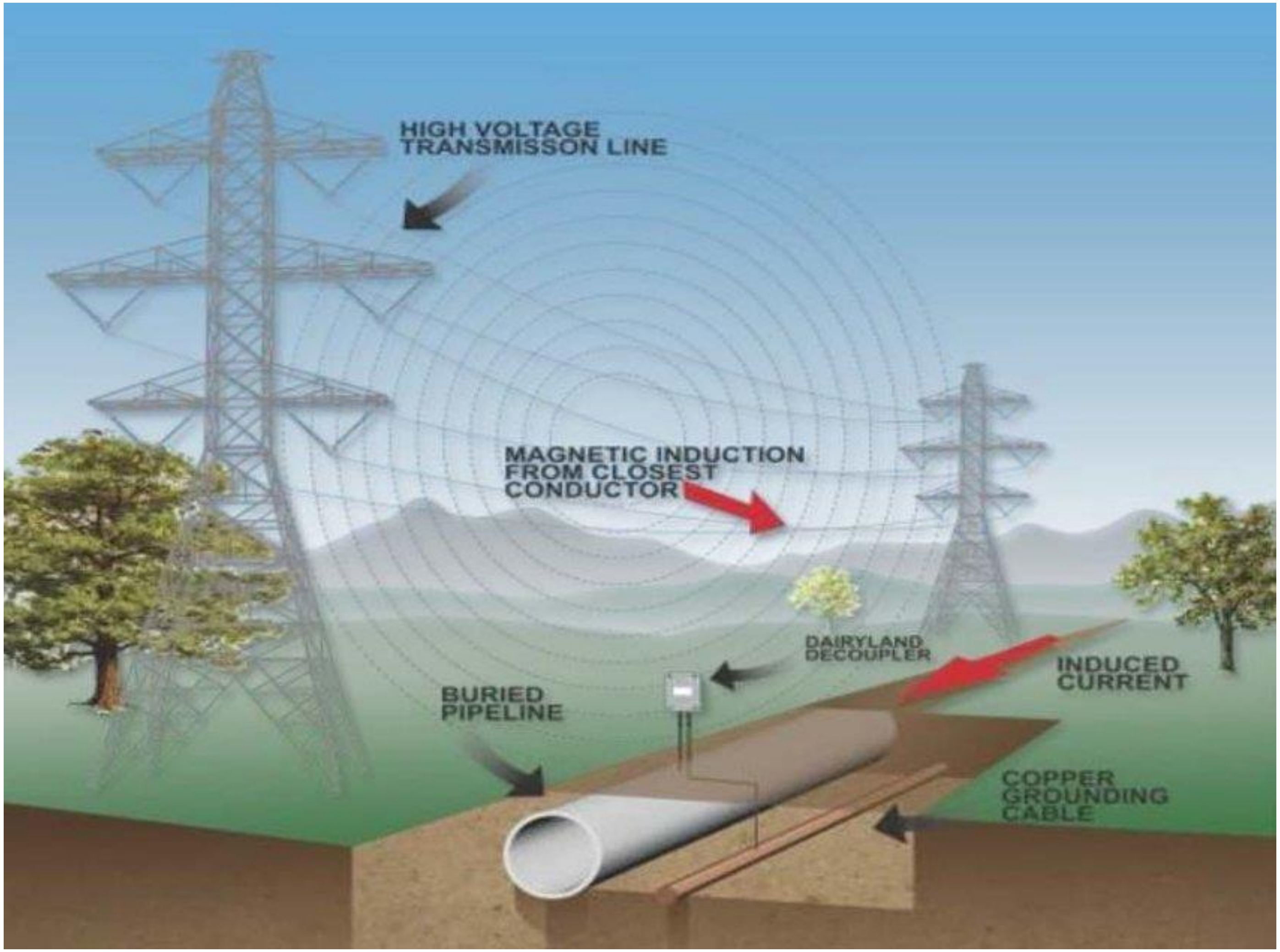
R.F. Allen, Ark Engineering and Technical Services, Inc. "AC Corrosion Issues"

AC Mitigation Analysis





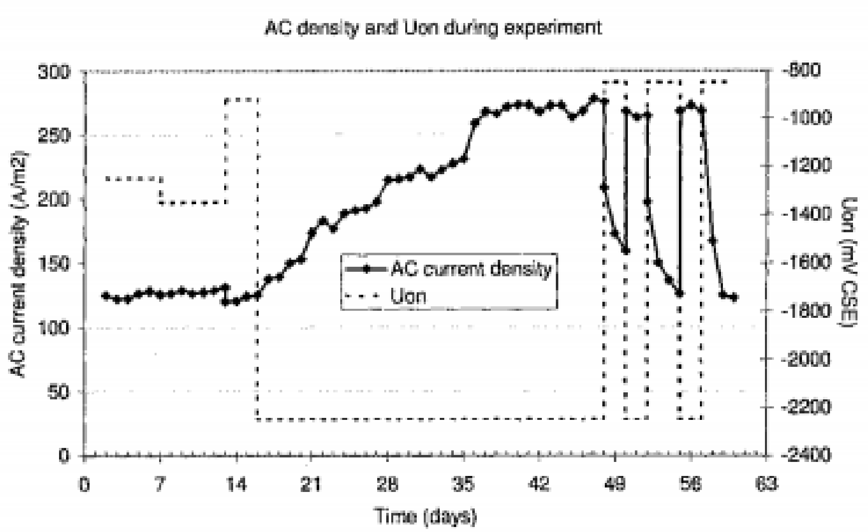
Traditional AC Mitigation



Business Use

AC Mitigation through Cathodic Protection

Excessive amounts of cathodic protection can increase AC corrosion rates.



Paper No. 05188 CORROSION2005

ROLE OF ALKALIZATION IN AC INDUCED CORROSION OF PIPELINES AND CONCEQUENCES HEREOF IN RELATION TO CP REQUIREMENTS

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ABSTRACT

In the present paper, characteristics of the AC corrosion problem are demonstrated using laboratory results and field measurements as examples.

Evidence has been given that the AC corrosion mechanisms involve alkalization of the environment nearby the coating defect, and in combination with AC, corrosion may be induced.

Accordingly, besides the level of induced AC voltage, the CP level has a dramatic influence on the AC corrosion process. Excessive CP increases the AC corrosion rate and should therefore be avoided. Increasing the CP seems definitely to be the wrong solution to a potential AC corrosion problem.

Keywords: AC corrosion mechanisms, alkalization, cathodic protection requirements.

INTRODUCTION

Energy corridors with pipelines routed in parallel with overhead electric power transmission lines and AC-traction railways may cause induced AC-voltages on the pipelines. These AC-voltages can cause personal hazards and may jeopardize integrity of the pipeline since even low AC-voltages may develop AC corrosion in coating faults. At NACE'2004, several papers [1-3] presented cases where AC induced corrosion in pipeline resulted in penetration rates as high as 10 mm/yr [2]. Hence, AC induced corrosion increasingly receives attention from pipeline operators.

A mechanism believed to be active in AC corrosion addresses the combined effect of alkalization of the environment close to the coating defect and the potential oscillation caused by the superimposed AC [4-10]. Current standardization work in Europe now includes the consequences in a corrigendum to the standard EN 12954 [11-12].

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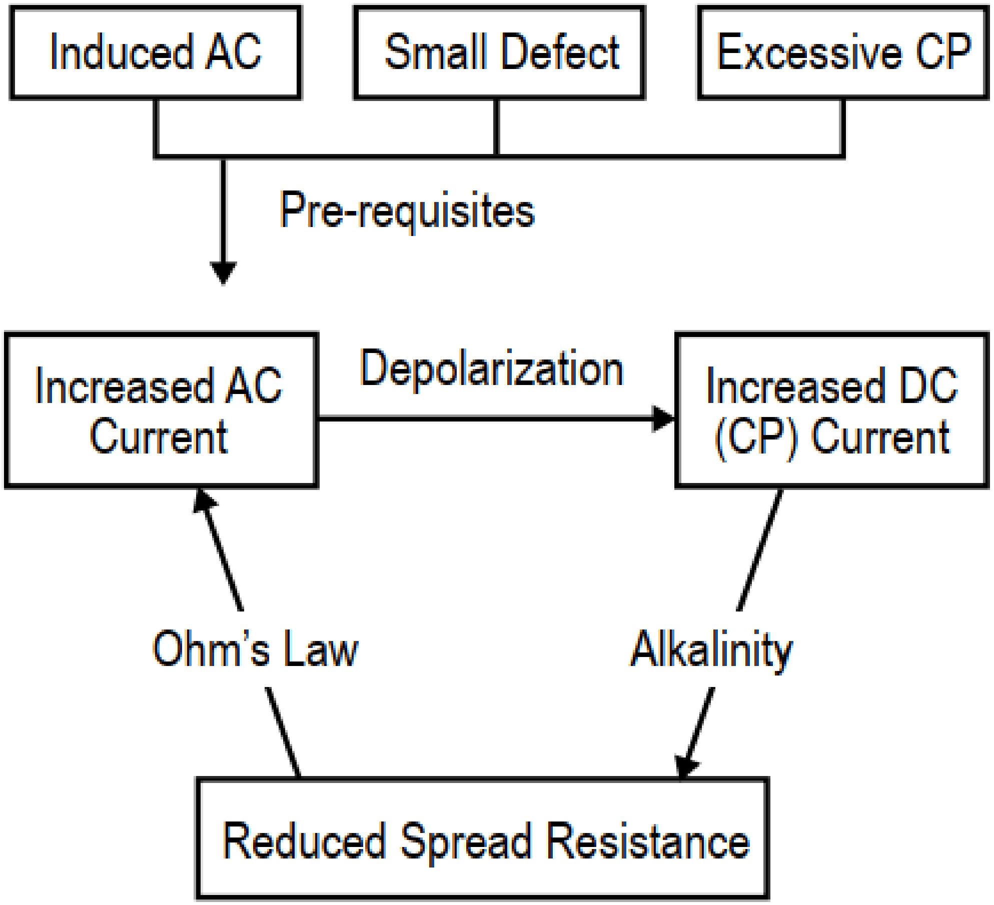
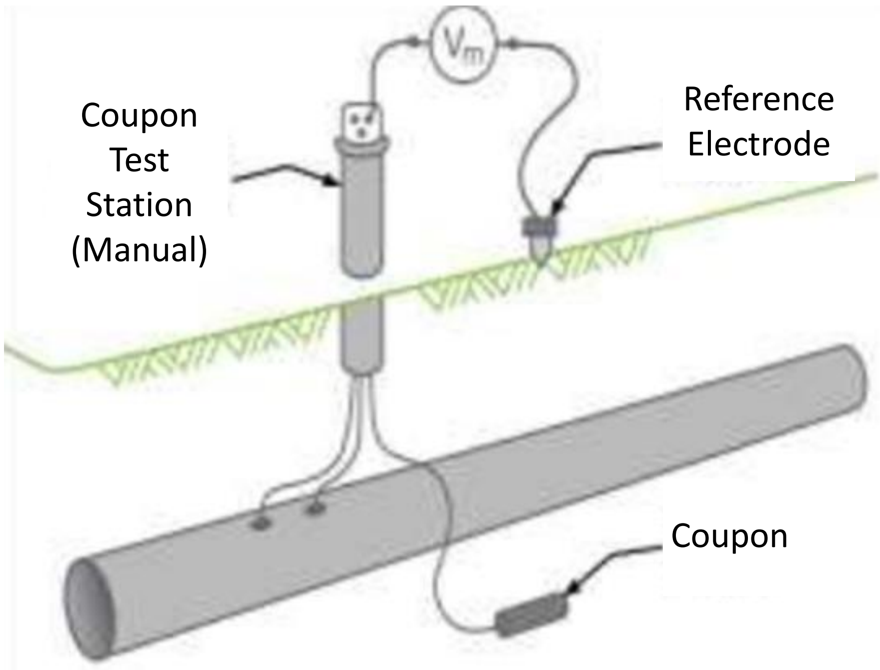
AC Mitigation through Cathodic Protection



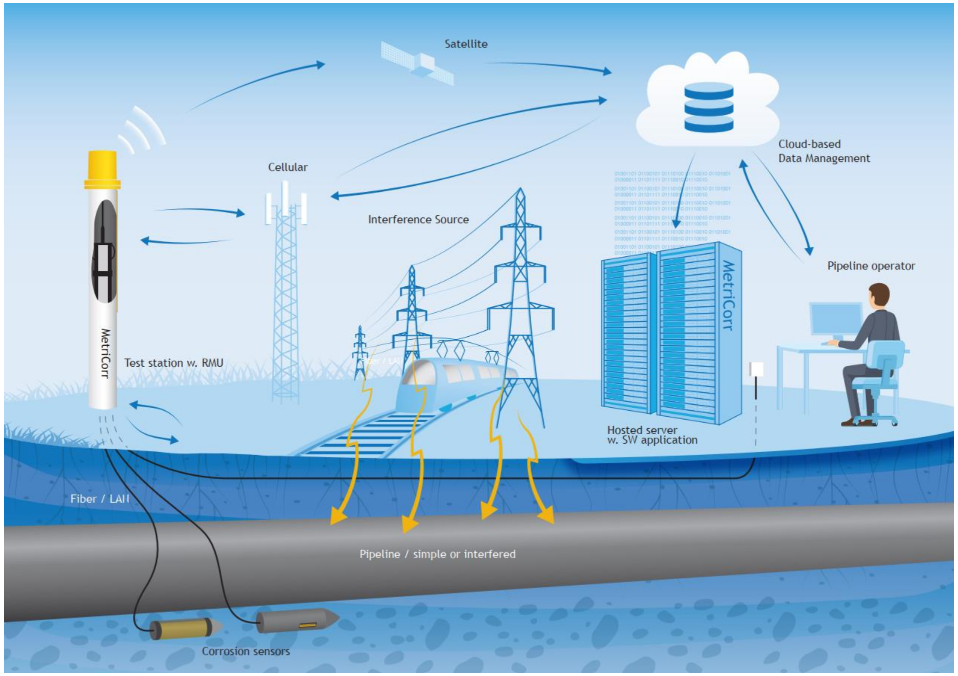
NACE SP2124-2018 “Alternating Current Corrosion on Cathodically Protected Pipelines: Risk Assessment, Mitigation, and Monitoring” 2017

Corrosion Coupon System

Standard Corrosion Coupon System

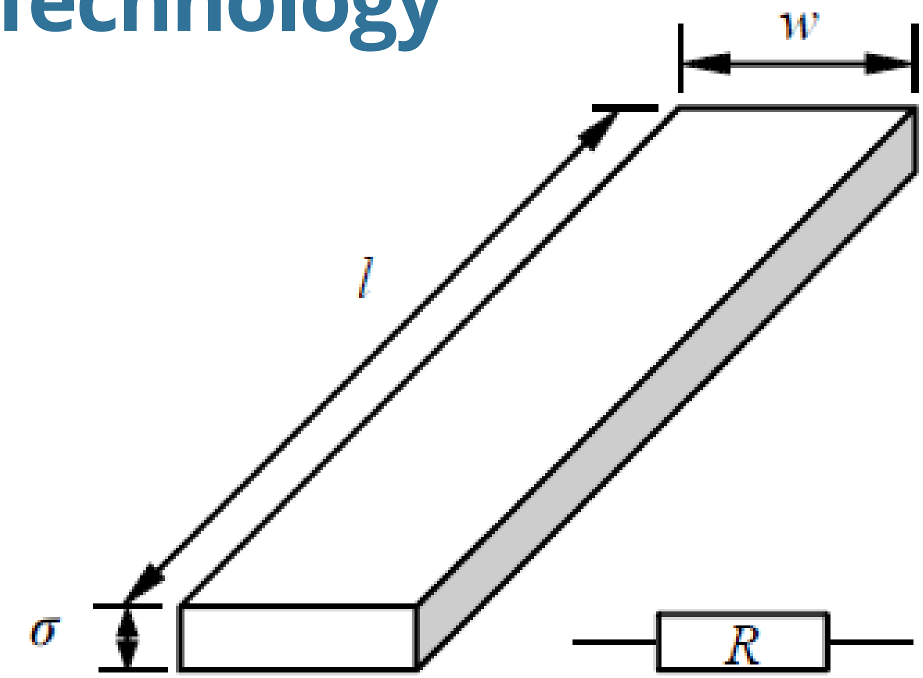


Active Corrosion Coupon Monitoring System



Electrical Resistance Technology

$$R = \rho(T)\frac{l}{w \cdot \sigma}$$



R – Electrical Resistance

ρ – Electrical Resistivity

T – Temperature

α - Temperature Coefficient of Resistivity

L.V. Nielsen and K.V. Nielsen, "Differential ER-Technology for Measuring Degree of Accumulated Corrosion as well as Instant Corrosion Rate, " in CORROSION, San Diego, California, 2003.

Electrical Resistance (ER) Probe

- Measurement of electrical resistance is used to determine metal loss
- Coupon sized to simulate worst case scenario
- Rugged design
- Long life

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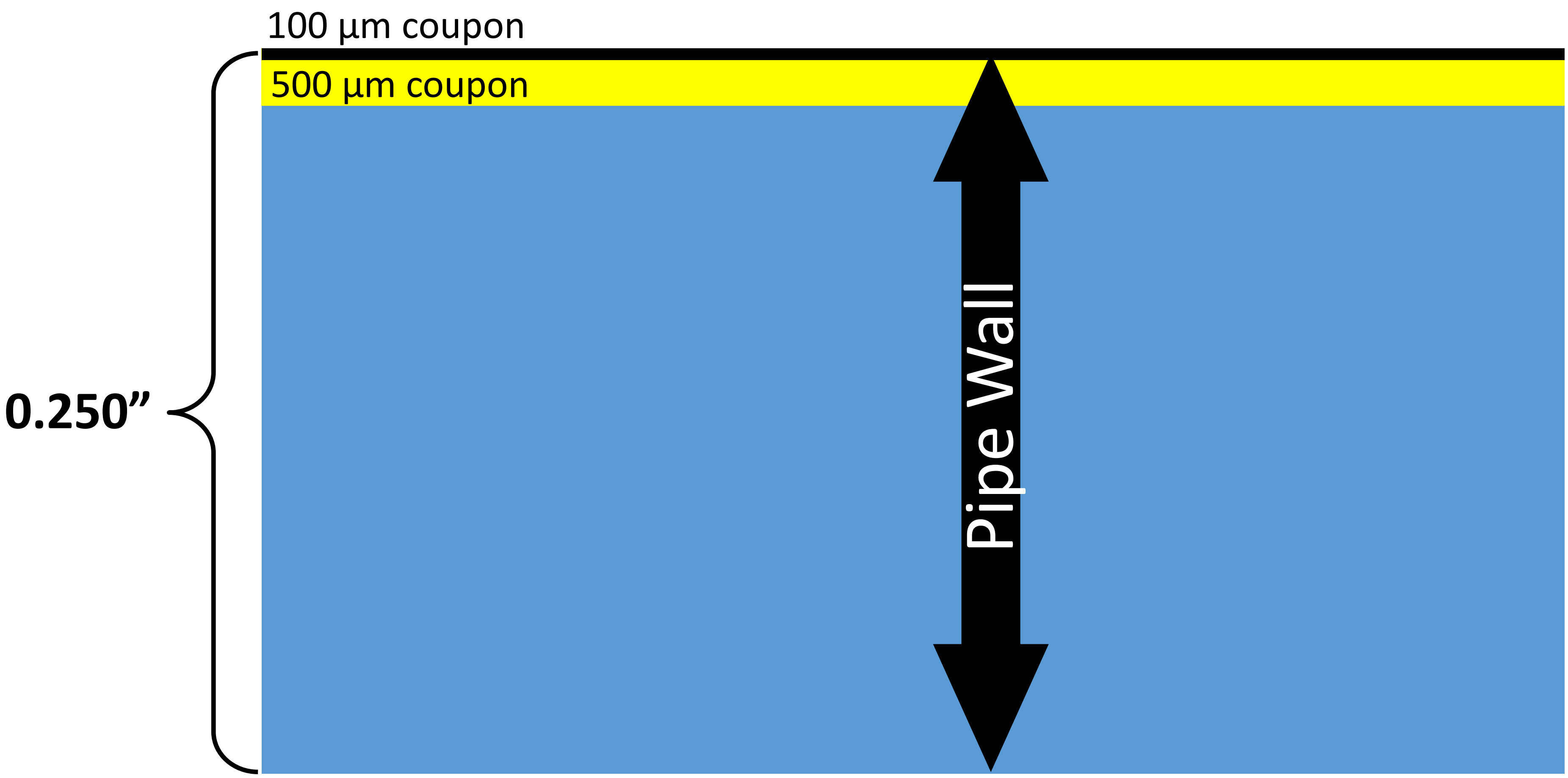
Coupon Size vs. Pipe Wall



Corrosion Indicator Reporting

Corrosion growth rate

< 25 µm/year (1 mil/year)

DC polarized potential

IR Free Read ≤ -850 mV

DC current density

< 1 A/m²

AC potential

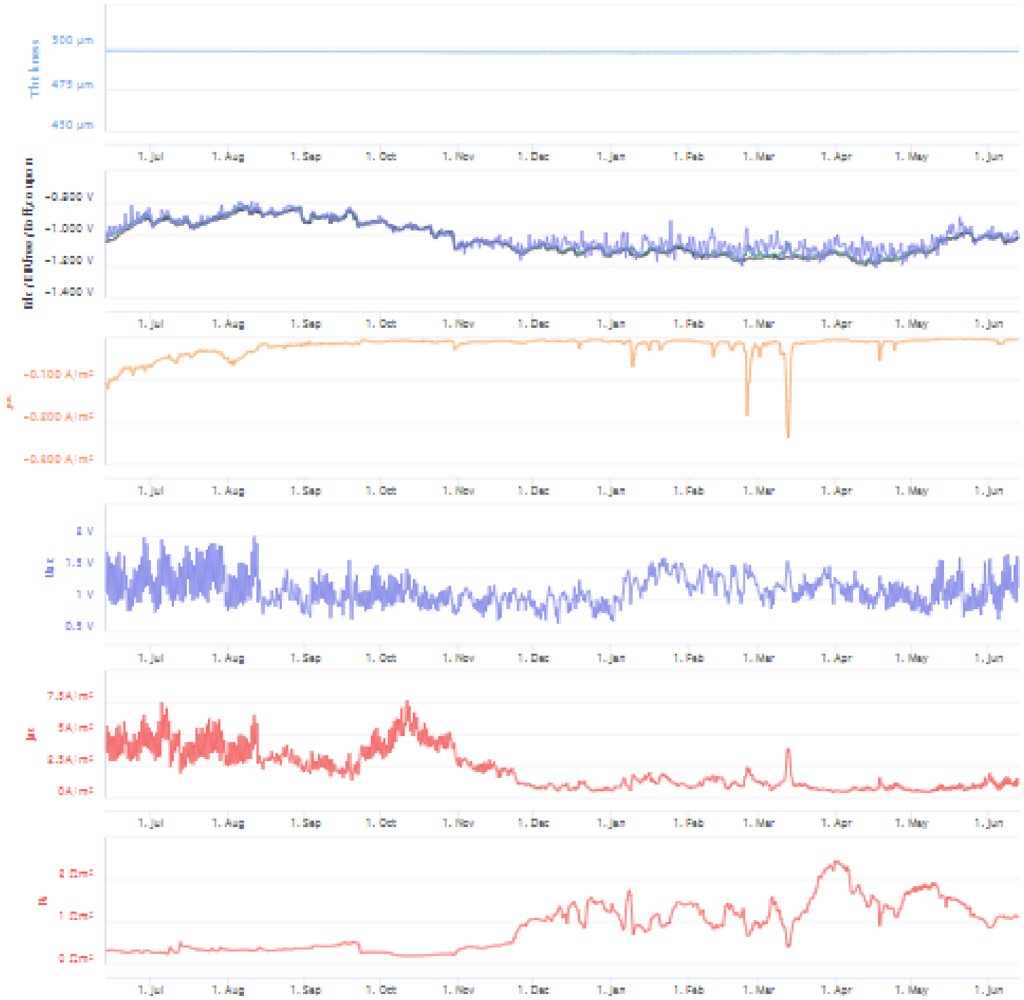
< 15 volts

AC current density

< 30 A/m²

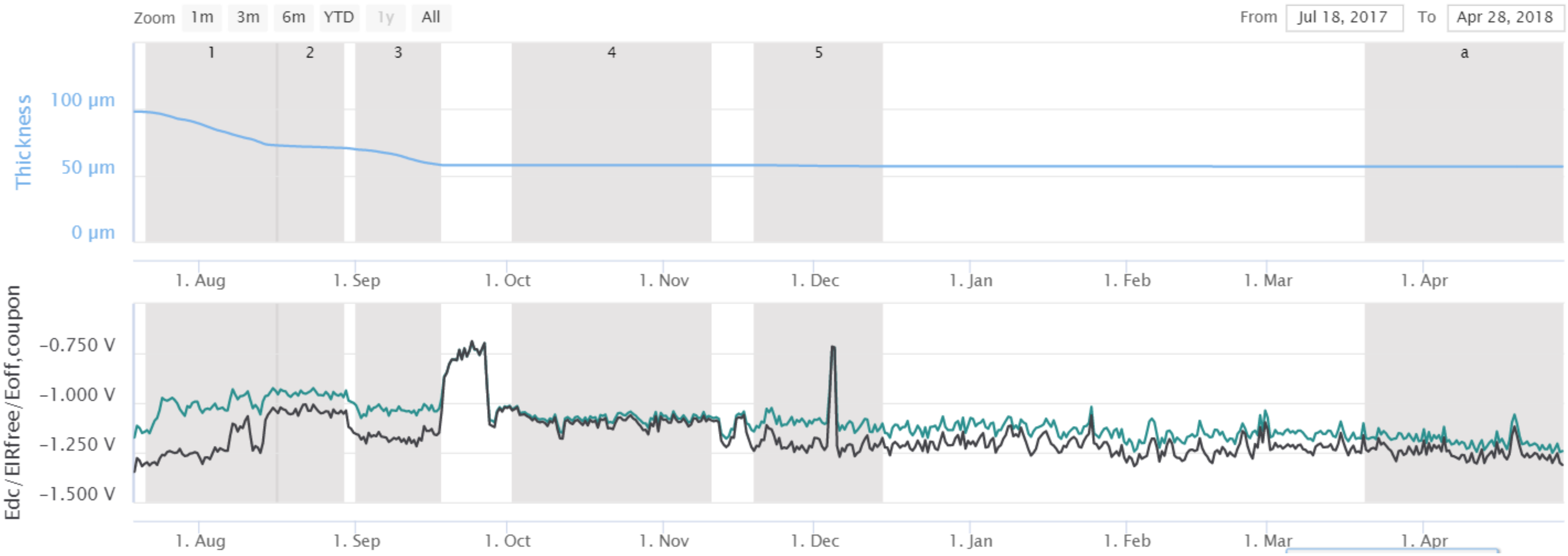
Spread resistance

Lower spread resistance can indicate an AC corrosion risk



Using Cathodic Protection to Mitigate AC Corrosion

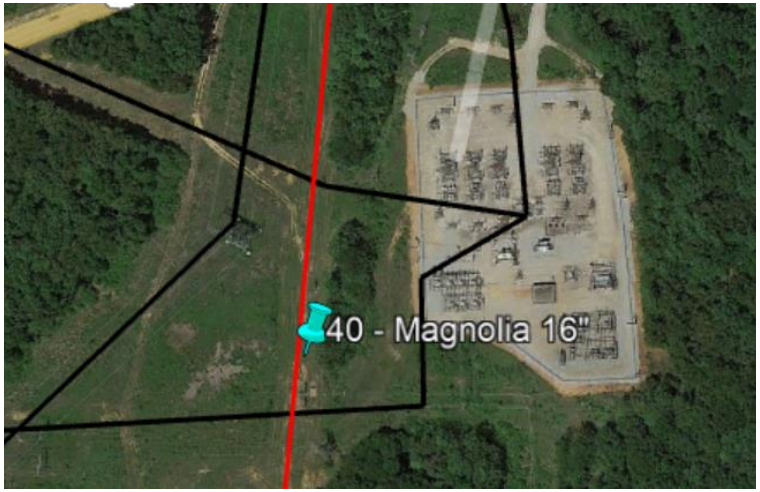
12” Transmission Line

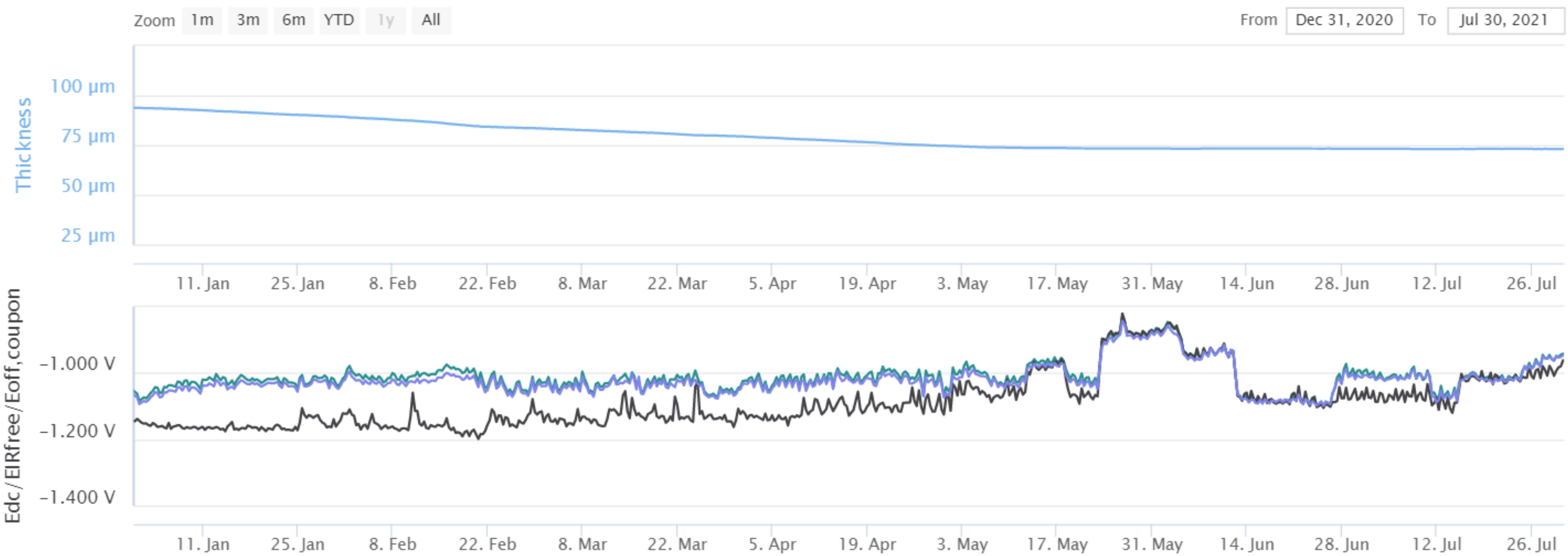


Business Use

Using Cathodic Protection to Mitigate AC Corrosion

16" Transmission Line near Substation





Regulations

49 CFR, 192.473 (a), Subpart I

Each operator whose pipeline system is subjected to stray currents shall have in effect a continuing program to minimize the detrimental effects of such currents.

Operators are now required to conduct interference surveys, analyze the results of the surveys to determine cause of the interference, and develop a remedial action plan to mitigate interference.

Active Corrosion Monitoring of Underground Steel Pipelines

Summary

- Detects interference and corrosion
- Reduces need for traditional AC mitigation $$$
- Monitors mitigation effectiveness
- Detects cathodic protection deficiencies
- Provides an immense amount of data
- Remote monitoring $$$

Questions?