UNDERSTANDING AC INTERFERENCE and MITIGATION SOLUTIONS

Alabama Public Service Commission
31st Annual Pipeline Safety Seminar
Montgomery, AL
December 4, 2018

Clay Brelsford
Bass Engineering Company
AC Interference

Co-Location
Pipelines
HVAC Power Systems
Creates Complex,
Electro-magnetic Interaction
Capacitive Coupling

Electric Field Influence
Inductive Coupling

Magnetic Field Influence

AC Power

Induced AC

Step-down transformer

many turns
high voltage
low current

few turns
low voltage
high current

load
Resistive Coupling

Shared Conductive Path

Fault or “Short-Circuit” HVAC Conditions

Lightning
AC Interference = Risk

- **Personnel**
  - Step-Step Potential
  - Step-Touch Potential

- **Pipeline Equipment**
  - Metering
  - Electrical Isolation

- **CP System**
  - ICCP/GCP Damage

- **Pipeline**
  - AC Corrosion
Resistive Coupling

Fault or “Short-Circuit” HVAC Conditions
AC Corrosion Morphology

Tubercle

Coating Deformation

Pits Within Pits
AC Corrosion Risk & AC Current Density

**ACCD**
- **< 20 A/M²**  
  - Low Risk
- **20-100 A/M²**  
  - Medium Likelihood
- **> 100 A/M²**  
  - Very High Likelihood

Expressed as a Function of AC Voltage & Soil Resistivity
Risk Factors

Multiple

Dynamic

Interactive

Geezzzz...Can I Get Some Help Here?
Federal Law

- 49 CFR 192.467 (f)
  - External Corrosion Control; Electrical Isolation
- 49 CFR 195.575 (e)
  - External Corrosion Control; Electrical Isolation
- 29 CFR 1910
- 29 CFR 1926

Yea...Not Really What I was Looking for....
NACE

• NACE SP0177-2014
  • Mitigation of Alternating Current and Lightning Effects on Metallic Structures and Corrosion Control Systems

• NACE SP21424-2018
  • Alternating Current Corrosion on Cathodically Protected Pipelines: Risk Assessment, Mitigation, and Monitoring

• AC Corrosion State-of-the-Art Report: Corrosion Rate, Mechanism, & Mitigation Requirements #35110

• NACE SP0104-2014
  • The Use of Coupons for Cathodic Protection Monitoring

• Technical Report on the Application & Interpretation of Data from External Coupons Used in the Evaluation of Cathodically Protected Metallic Structures #35201
Other

- **Canadian Standard**
  - CAN/CSA – C22.3 No. 6-13
    - Principles and Practices of Electrical Coordination Between Pipelines and Electric Supply Lines

- **European Standard**
  - BS EN 15280:2013
    - Evaluation of AC Corrosion Likelihood of Buried Pipelines Applicable to Cathodically Protected Pipelines

- **Interstate Natural Gas Association of America (INGAA)**
  - Criteria for Pipelines Co-existing with Electric Power Lines; 2015-04 Final Report

- **National Electric Code (NEC), Article 250**
  - Grounding & Bonding

- **Institute of Electrical & Electronic Engineers (IEEE)**

- **PRCI**
  - On-going Research; EC 6-2, EC 6-4
Confused?
AC Interference Threat Risk Assessment

Apply Industry Risk Concepts

**RECEPTOR**
An object impacted by an abnormal event or failure. Personnel, PL Assets, CP Systems

**LOCATION**
A position or site marked by some distinguishing feature. Aboveground appurtenances, station numbers

**MECHANISM**
A natural or established process by which something takes place or is brought about. Capacitive, Inductive & Resistive Coupling

**THREAT**
An indication of something impending. Elevated AC potentials, elevated AC current density, step/touch potentials

**FACTOR**
Something that actively contributes to the production of a result. Lateral separation distance, co-location length, crossing angle, soil resistivity, HVAC current, etc.
Threat Risk Assessment; Resistive Coupling

- **RECEPTOR**: Personnel Electrical Isolation
- **LOCATION**: Valve setting; ID by station #
- **MECHANISM**: Resistive Coupling
- **THREAT**: Elevated AC potentials Step-touch potentials
- **FACTOR**: Lateral separation distance Soil resistivity
AC Threat Risk Factors

1. Geospatial Relationship
   - Lateral Separation Distance*
   - Collocation Length*
   - Crossing Angle*

2. HVAC System Operating Parameters
   - HVAC Current*
   - HVAC Voltage
   - Fault Current Load

3. Environmental Conditions
   - Soil Resistivity*
   - AC Current Density

4. Pipeline Design
   - Coating Resistance
   - Aboveground Appurtenances
   - Cased Crossings

* indicates factors that require additional consideration or measurement.
Over 7,000 miles of transmission PL and large diameter distribution mains serving several rural and major metropolitan areas

Assets spread over six environmental geographies

Wide ranging pipe design and operating parameters
Analyze HVAC Data

Obtained **41,322** miles of HVAC centerline and operational data from Platts, PennWell, & RexTag

Converted Rated Voltage to AC Current

- **0-69 kV**
- **70-138 kV**
- **138-230 kV**
- **231-345 kV**
- **346-500 kV**
Utilize GIS tools to determine

- Lateral separation distance
- Co-location length
- Co-location angle
- Crossing angle
Geospatial Analysis; Soil Resistivity

Vast pipeline system spread across 6 geographical regions

Acquired USGS SSURGO soils data

Utilize UGIS tools to determine soil resistivity for co-location
AC Threat Risk Analysis

Import GIS Data into RIPL
- Separation Distance
- Co-location Length
- Co-location Angle
- Crossing Angle
- HVAC Voltage
- HVAC Current
- Soil Resistivity

Combined with Existing:
- Pipe Coating Resistance

Create Threat Ranking
Analysis dynamically segmenting and ranking PL based on specific factors combined into a threat score
Engineered Field Analysis

• Differentiate above & below ground assets
  • Design gradient control mats

• Identify electrical isolation locations
  • Design decoupler installations

• Design engineered grounding system locations
  • Incorporate “natural” grounding

• Address lightning mitigation

• Address safe arc distance
  • Substations, guy anchors, etc.

• Incorporate AC mitigation system monitoring
AC & Lightning Mitigation Tools

• Engineering Controls
• Decoupling Devices
• Engineered Grounding Systems
• Gradient Control Mats
• Coupon Test Stations
Signage

WARNING!
AC VOLTAGE MAY BE PRESENT ON THE FENCE AND/OR PIPELINE
Dead Front Test Stations
Decoupling Devices

Zinc Anode Pair

Polarization Cell Replacement (PCR)

Solid State Decoupler (SSD)
Engineered Grounding Systems

Deep Vertical Point Ground (DVPG)
Engineered Grounding Systems

Natural Grounds

- Pipeline
- Casing
Gradient Control Mats

Magnesium Anode

Step Voltage

Touch Voltage
Gradient Control Mat Assembly

Exothermically Welded @ Seams on 18” Centers
Lead Length is Critical!

Pin Brazed Connections
Monitoring

- Measure PL AC & DC P/S Potentials
- Measure AC & DC Current
- Calculate PL AC & DC Current Density
Remote Monitoring w/ CTS

The RM4210 integrates with Bullhorn Web, allowing you to access your measurements or update configurations from nearly anywhere.
The Complete Package

• AC Threat Risk Analysis
  • Prioritize pipeline assets at risk

• Engineered Field Analysis
  • Gather critical field data
    • Soil resistance
    • Electrical isolation locations
    • Aboveground assets/security dimensions
    • Cased crossings
    • HVAC guyed anchors
Summary

• AC Interference is Complex
• Influenced by Design & Operating Conditions...Dynamic!
• Design Protocol
  • AC Threat Risk Analysis w/ Engineered Field Design
• Integrated ACLM Solution Using Multiple AC Mitigation Tools
• Monitor!!
Clay Brelsford
Bass Engineering Company

CLAY.BRELSFORD@BASS-ENG.COM

903-759-1633