

An Operator's Experience with AC Induced Corrosion

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ABSTRACT

This paper presents a case study of a pipeline release attributed to AC induced corrosion. Shortcomings were identified in the operator's integrity and corrosion programs which would normally prevent such a release. Based on the findings, the operator completed additional excavations, conducted an AC interference study, and developed an enterprise wide program focused on identifying, monitoring, and mitigating AC interference. The paper examines the results of each mitigative action and process adjustment taken by the operator.

Key words: AC Corrosion, ILI, AC Interference, Interference, AC Mitigation

BACKGROUND

During the summer of 2016 an in-service leak was discovered on a pipeline carrying highly volatile liquids (HVLs) outside of Houston, Texas. The pipeline of interest is an 8 inch (200 mm), 0.358 inch (9.1 mm) wall thickness, grade X52 line that shares a right-of-way (ROW) with several other pipelines and multiple 345 kV powerlines. Many of the pipelines within the ROW are electrically continuous through various connections and bonds. The pipeline was constructed in 1979 and is coated in vintage fusion-bonded epoxy (FBE).

The pipeline of interest is protected by multiple impressed current cathodic protection (CP) systems with the closest rectifier and groundbed to the release site approximately 2 miles away. A close interval survey (CIS) was performed on the pipeline in March of 2015. Instant off potentials collected near the release site were approximately -1.2 V vs. copper-copper sulfate reference electrode (CSE).

The previous two in-line inspection (ILI) assessments consisted of a caliper and magnetic flux leakage (MFL) tool in 2009, and a caliper, GPS, and ultrasonic wall measurement (UTWM) in 2013. The through wall anomaly was reported as a 49% metal loss feature in 2009 and as a 25% manufacturing indication in 2013. The same ILI vendor was used in both runs. A summary of the ILI results can be seen below in Figure 1 and an image of the through wall anomaly in Figure 2.

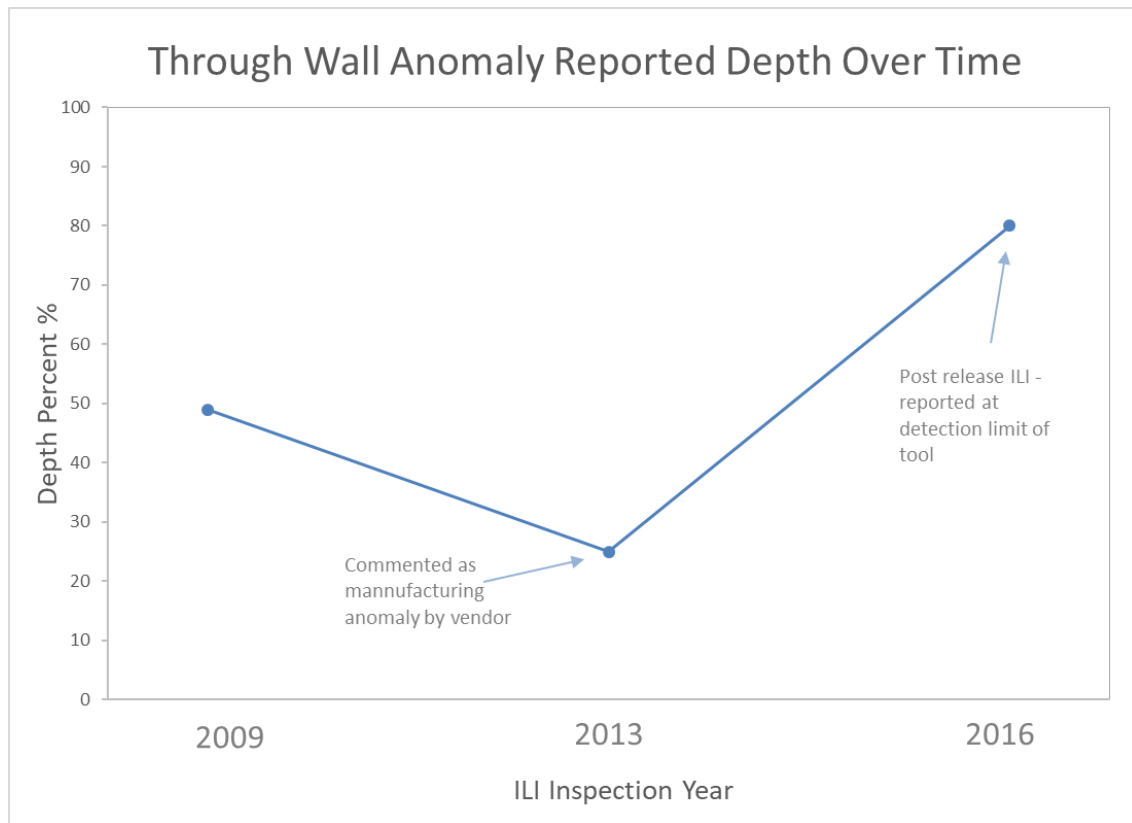


Figure 1: Through wall anomaly reported depths over successive ILI assessments



Figure 2: Through wall anomaly

ROOT CAUSE

In order to have a release of this nature, several preventative measures had to fail.

According to NACE SP21424-2018¹, DC current densities need to be considered when evaluating a pipeline for susceptibility to AC induced corrosion. In this case, the CP polarized potentials were measured around -1.2 V vs. CSE near the release site. The pipeline of interest shares a ROW with several other pipelines and is electrically continuous with many of them. Maintaining polarized potentials more electropositive than -1.2 vs. CSE is difficult due to influence from foreign CP systems. At the time of the release, no coupons were installed to measure the DC current density experienced by the pipeline. However, considering the elevated CP polarized potentials and coating disbondment discovered during excavation, the DC current densities were likely elevated on much of the system.

Prior to the release, detection of AC interference was completed by analysis of annual survey AC voltage readings. AC voltage readings collected at a test station approximately 1,000 feet from the release site were 3.74 V_{AC} in February of 2015 and 2.70 V_{AC} in February of 2016. AC interference was not considered a threat in this area based on the relatively low amount of induced AC voltage measured during annual survey.

The impact of low soil resistivity was not considered when analyzing the annual survey AC voltage data. The soil resistivity near the release site was measured between 700 to 900 ohm-cm. Using 800 ohm-cm soil resistivity and the AC voltages recorded, the theoretical AC current density on a 1 cm² coating holiday calculates to 106 A/m² in 2015 and 76 A/m² in 2016. It has also been demonstrated on this pipeline that the AC voltages fluctuate daily and seasonally based on powerline loads, further impacting the AC current densities experienced.

The 2013 ILI assessment further hindered the identification of ongoing AC induced corrosion. The pipeline of interest transports HVLs which can create issues for ultrasonic ILI tools in accurately sizing and detecting metal loss features. The eventual through wall anomaly was classified as a 25% manufacturing indication and was not considered an integrity concern.

A summary of the contributing factors to the in-service leak can be seen in Figure 3.

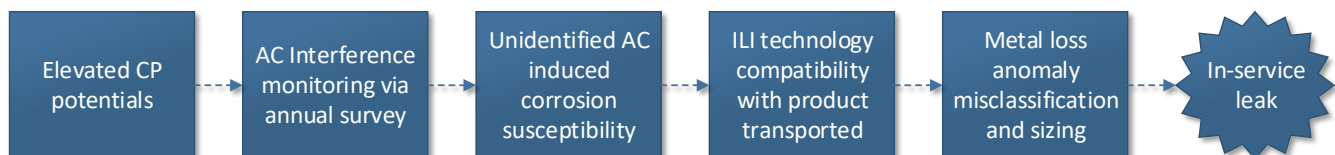


Figure 3: Factors contributing to in-service leak

IMMEDIATE RESPONSE

A high resolution MFL ILI inspection was conducted after the release to ensure the integrity of the pipeline and determine if other features from the 2013 ILI assessment had been misclassified. The new ILI tool did not report any immediate conditions on the line.

A system wide AC interference study was conducted to identify additional locations susceptible to AC induced corrosion, arcing damage, and elevated coating stress voltages during a fault. The interference study included AC voltage measurements, soil resistivity measurements, 24-hour data logger measurements, modeling, and mitigation design. The study concluded that most of the pipeline system had AC current densities in excess of 20 A/m² and was susceptible to AC induced corrosion. A graph of the AC current density profile near the release site can be seen below in Figure 4. The as-