

DNV Columbus Technology Update

Issue no. 1 2009

A Shocking Corrosion Problem

The effects of alternating current corrosion and interference on pipelines

As more and more buried pipelines are having to share rights-of-way with HVAC transmission lines, alternating current (AC) interference issues have become a more common problem. Not only can this be a safety issue for your personnel, but it can also impact the integrity of the pipeline itself.

Pipelines sharing, paralleling or crossing high voltage alternating current (HVAC) transmission line rights-of-way (ROW) may be subjected to electrical interference from electromagnetic inductive, conductive and capacitive effects. If these electrical effects are great enough during steady state normal operation, a potential shock hazard exists for anyone that touches an exposed part of the pipeline, such as a valve, cathodic protection (CP) test station or other aboveground apparatus of the pipeline. During steady state normal transmission line operation AC current density at a coating flaw above a certain threshold may cause accelerated external corrosion damage to the pipeline. In addition, damage to the pipeline or its coating can occur if the voltage between the pipeline and surrounding soil becomes excessive during a fault condition.

In terms of personnel safety, the concern is the voltage a person is exposed to when touching or standing near the pipeline. An evaluation of the potential risk to personnel safety for those working on the pipeline and possible pipeline coating damage should take place whenever a pipeline is in close proximity to a HVAC transmission line.

A phase to ground fault on a power transmission line, although normally only lasting less than a second, can cause damage to a pipeline from high potential breakdown of the coating, resistive/conductive arcing across the coating near the fault and high-induced currents along the ROW. These high currents may result in arc damage at locations remote from the fault where a low resistance path to power ground is found. If these currents are high enough, they may cause damage to the pipe wall even to the point that it burns through the pipe wall. The high current density can cause molten pits on the pipe surface with cracks developing when the fault ceases and the pipe cools.

Pipeline corrosion control considerations involving AC transmission lines include coating damage during faults and accelerated corrosion (even in the presence of adequate levels of cathodic protection) due to high AC current density at coating flaws. Fault current conditions that produce excess voltages across the coating are of concern for high dielectric coatings.

Currently in the United States, alternating current mitigation is typically driven by safety considerations, though pipe integrity concerns related to AC corrosion are growing. Typical means of AC mitigation include the installation of zinc/magnesium ribbon anodes or prepackaged magnesium anodes, which may be coupled to the pipe through a diode circuit to limit the corrosion of the zinc/magnesium to "free corrosion." Additional means of AC mitigation involve the installation of grounding electrodes coupled to the pipe via capacitors, polarization cells or other electrical isolation devices.

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Numerous investigations have shown that above a minimum AC current density, normal levels of cathodic protection will not control AC corrosion. The generally accepted AC current density ranges and associated corrosion risks are:

- AC-induced corrosion doesn't occur at AC current densities less than 20 amps per meter squared (A/m^2)
- AC corrosion is unpredictable for AC current densities between 20 and 100 A/m^2
- AC corrosion occurs at current densities greater than 100 A/m^2

The key aspect is that the AC voltage must be mitigated to relatively low levels; the NACE safety standard in RP0177, which mainly considers personnel safety, may not be sufficient in many cases. Considering that the primary factor in determining the possibility for the presence of AC corrosion is the AC current density, monitoring the current density rather than an AC voltage is crucial to assessing the AC current-related hazards to a buried pipeline.

Monitoring AC current density may be accomplished by installing coupon test stations (CTS) along the affected structure. The choice of the installation sites would be predicated on information gleaned from field measurements, such as a close interval survey consisting of both DC and AC pipe-to-soil potential readings.

Pipelines that share right-of-way with power utilities are faced with additional safety and integrity issues that must be addressed. Recent research and experience has advanced the pipeline industry's understanding of these problems to the point that no system should be adversely affected from an integrity or safety standpoint.

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