

Selection and Optimization of Test Points to Adequately Verify the Performance of Cathodic Protection Systems

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Abstract

It is common practice for hazardous product pipeline operators to schedule physical cathodic protection (CP) pipe-to-soil (p/s) potential measurements from every available test post on all pipelines annually. Historical data confirms that when the cathodic system output remains consistent; protection levels will typically not vary significantly from year to year. Such conventional annual CP survey practice is not mandated by North American standards or codes but is rather part of the integrity management process. The practice of annual conventional test point measurement carries a high labor cost and may only achieve marginal value in the performance assessment of a cathodic protection system and overall pipeline integrity. Effective evaluation of annual CP system performance can be accomplished without necessarily collecting data from every test post, every year. It can be achieved by taking a proactive/performance based external corrosion prevention (ECP) management approach that is aligned with other pipeline integrity programs, and utilizes all available relevant information.

This paper presents a concept and methodology on optimising cathodic protection field data collection in alignment with a comprehensively progressive and proactive performance based ECP program to maintain pipeline safety.

Introduction

In 2019, the Enbridge Pipeline Integrity External Corrosion Prevention (PI-ECP) team explored, developed and proposed realignment of CP monitoring requirements. It was realized that external corrosion threat risk determination and economic gains could be accomplished without compromising the safe operation of the pipeline system through utilization of new monitoring technologies, sound engineering practices and risk-based programs. Shifting from the conventional time-based monitoring/reactive maintenance program to a predictive forecasting/performance strategy using advanced diagnostics and modelling was proposed to provide the input for improved long-range forecasting (LRF).

In 2020, during the height of the COVID-19 pandemic, the ECP team was tasked with conducting an annual survey across Canada and the United States while reducing the potential exposure of employees, contractors and the public. Company policy, combined with varying State/Provincial and local jurisdictional policies surrounding travel, quarantines and interpretation “essential work” presented a unique challenge. Subsequently, the ECP team needed to consider the annual survey data from a different perspective and expedited implementation of the performance-based CP evaluation philosophy. Conveniently, the foundational elements of the concept had already been considered and partially established.

Existing regulations require TP to be installed “at intervals frequent enough to obtain electrical measurements indicating the adequacy of cathodic protection.”¹ Historically, together with annual reporting requirements, this has been interpreted as requiring information to be gathered from test posts at pre-defined intervals to evaluate the adequacy of the cathodic protection system. As a result, many pipeline operators test posts typically installed at 1.5 to 3km (1 to 2 mile) intervals, in addition to foreign line crossings, cased crossings and environmentally sensitive areas.

Legacy interpretation of the regulations has resulted in the installation of more than 44,000 test posts over 66,000 km (41,000 miles) of right-of-way. Maintaining these TP and attempting to acquire information from each one annually results in high costs that must be justified. It has been identified that certain TP locations are key in establishing representation of CP adequacy, while the data from others is marginally useful and predicable despite being collected persistently from year to year.

Objective

¹ Code of Federal Regulations, 49 CFR Transportation 195.567 (b) (1)

The objective of the study was to develop a methodology to identify TP that are key to identifying unchanged satisfactory performance of the CP system and which TP could be considered supplemental without compromising corrosion integrity risk. Bypassing measurements at “non-essential” locations would reduce the number of TP surveyed and ultimately reduce the time (risk) contractors and employees would spend potentially exposing themselves and others to COVID-19.

Since the method was unprecedented, established enterprise decision effectiveness processes were applied at a departmental level to achieve approval for the approach. The ECP team was tasked with the decision of whether surveying all TP would be necessary to determine adequate CP was being accomplished. The ECP team proposed three categories of test posts:

- Anchor – Those TP essential to monitor annually as key indicators of unchanged CP performance
- Monitor – Those TP that provide important information as may be dictated by interactive parameters such as high consequence areas, susceptibility to interference, previously detected corrosion, or insufficient historical data.
- Supplementary – Those TP, perhaps costly to access, and assessed as having no benefit to immediate pipeline corrosion integrity assessment. Further, their omission from any particular annual survey could be considered without compromising corrosion integrity risk.

Information Utilized and Assessment Method

Corrosion Control Database

A corrosion control data base is repository that contains all historic corrosion control data on the system. The data includes pipeline characteristics and attributes as well as details of the cathodic protection systems and soil corrosivity information. Historical CP survey information, (rectifier output, test point, CIPS and coupon data) along with any ECDA investigations, other data and any rehabilitation are documented. A comprehensive database, including IR Free p/s data, is essential to pipeline corrosion integrity management. Data in this database provides invaluable insight into the history of the pipeline operations and is the source of historical data for this study.

Metal Loss Inline Inspection Data Integration

Inline inspection metal loss data was the primary contributing information set that was considered to be incorporated. ILI is the predominant tool for evaluating corrosion in transmission pipelines. Important information from the ILI reports includes remaining wall thickness (wall loss) and corrosion cluster (feature) density. This data is used to calculate corrosion rate. Data from two or more ILI data sets is used to calculate short term corrosion rate, sometimes also described as “back-to-back corrosion rate” or corrosion growth rate (CGR). This last parameter is useful in evaluation the performance of the current corrosion protection system and distinct from the historical total corrosion.

The evaluation included statistical analysis of CGR. The respective average CGR value was applied as a lagging performance indicator to infer effectiveness of historical cathodic