

Monitoring DC Decoupling Devices at Isolation Flanges for Compliance and Pipeline Integrity

Jamey Hilleary
Director of M2M Products
Elecsys Corporation

Jerry Dewitt
Senior Cathodic Protection Specialist
Enbridge Pipelines Inc.

Len Krissa, P.Eng.
Engineering Specialist
Enbridge Pipelines Inc.

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Abstract

It is a common practice to install DC decoupling devices at pipeline joints where isolation flanges are installed. The decoupling device protects the isolation gasket from damage as a result of lightning or AC ground faults, including the possibility of fire. Historically, it has been less common to verify the operation of the decoupling devices deployed at isolation flange locations. This is likely due to several factors. First, decoupling devices are very reliable and the failure rate, even in extreme conditions, is very low. This fact creates a perception that once installed little or no attention is necessary. Second, the locations at which these devices are too numerous and widespread to physically inspect these devices at two month frequencies. Third, and most important in regards to this paper, there is a misconception that annual survey readings on these devices are sufficient to ensure operational integrity. Decoupling devices may utilize diodes and as such are subject to PHMSA regulations that require readings to be taken six times a year on rectifiers, critical bonds, reverse current switches and diodes.

The use of isolation flanges is widespread to electrically separate cathodically protected structures from above ground facilities, at the upstream and downstream mainline junctions at stations, isolating at city gates, and isolation at custody transfer points for natural gas and flammable liquid pipeline systems. Any of these locations where decoupling devices are deployed on federally regulated pipelines are subject to operational integrity verification every two months.

Remote monitoring devices are an ideal solution to the inadvertent neglect or additional labor that can occur pertaining to the bi-monthly interrogation of decoupling devices. Currently available monitoring systems have the capability to measure the AC passing through the decoupling device, DC bonds, as well as changes in DC pipe to soil potentials, AC voltage potentials, and AC and DC current densities. This technology provides periodic and veritable measurements of all monitored parameters, with scheduled reports back to the Operator for use in compliance reporting. Alarm thresholds can be assigned on each monitored parameter, thereby providing immediate notification of equipment malfunction or failure. Additionally, all data measurements can be logged in local memory storage for retrieval of detail data in the event of an extended alarm condition. This technology provides the Operator with all the information necessary to immediately assess the integrity of the decoupling system as well as monitoring for unrelated anomalous conditions at the site.

This paper is a case study of multiple sites employing the use of monitoring equipment for the purpose of evaluating the operational integrity of decoupling devices at isolation flanges. Methods, best practices, and challenges will be addressed, providing the necessary information to successfully implement this solution at similar locations.

Introduction

Induced AC on buried pipelines has garnered much attention in recent years from both a safety concern, and increasingly, concerns regarding pipeline corrosion due to AC discharge at holidays. The problems associated with AC on buried pipeline structures are exacerbated by the increased number of areas where buried pipelines share right of way with high-voltage overhead transmission power lines. Induced AC levels tend to fluctuate with the power load changes on the influencing overhead transmission lines. These fluctuations follow changes in power demand that occur daily as power requirements shift from the urban core to the suburbs, weekly as demand patterns shift over the weekends, and seasonally as power requirements associated with heating and cooling affect demand.

As the pipeline integrity and compliance issues associated with induced AC have risen in profile, new monitoring devices have been developed for the purpose of detecting and measuring these currents. Monitoring devices incorporating more frequent measurement intervals, ability to measure AC voltage, current density, current drain values, and log data to internal memory provide critical data necessary to verify the adequate performance of AC mitigation systems. Using these tools for monitoring the performance of decoupling devices at isolation flanges provides a method for continuous verification of proper operation.

Case Study 1

The site selected for this case study is a monolithic type isolation flange installed at the junction of a liquid products pipeline connected to a terminal. There was a negligible amount of AC

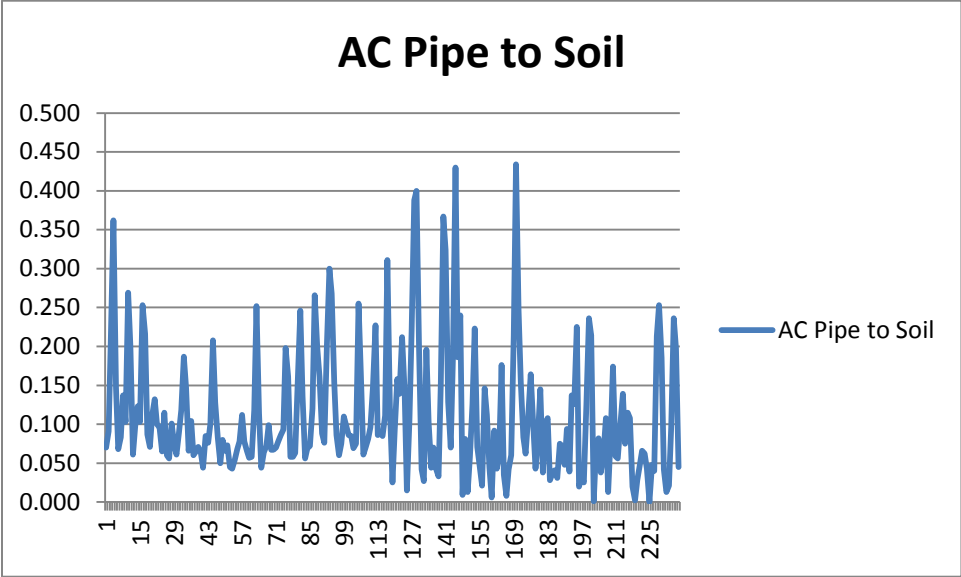
voltage on the transmission pipeline ($<0.5\text{VAC}$) with no measurable AC corrosion current density. A decoupling device was installed to allow any surges or ground fault currents to bypass the flange. As steady state AC was not expected to present a problem at this site, the focus was primarily on monitoring the DC structure to soil potentials ensuring the flange was providing complete isolation of cathodic protection currents on the two structures. Additionally, AC voltage potential and current density was continuously measured on the transmission pipeline side in order to detect any unexpected changes in AC levels.

At the pilot site (and subsequent installations) the solid-state decoupling device was installed inside a junction box positioned over the area where the isolation device was situated. Measurement and potential bond leads were attached to the pipelines on each side of the flange. A reference cell, protected coupon (bonded to the transmission pipeline), and an unprotected coupon were installed at the site. All of the leads were terminated in the junction box. A remote monitoring device was installed adjacent to the decoupling device in the junction box (figure 1).

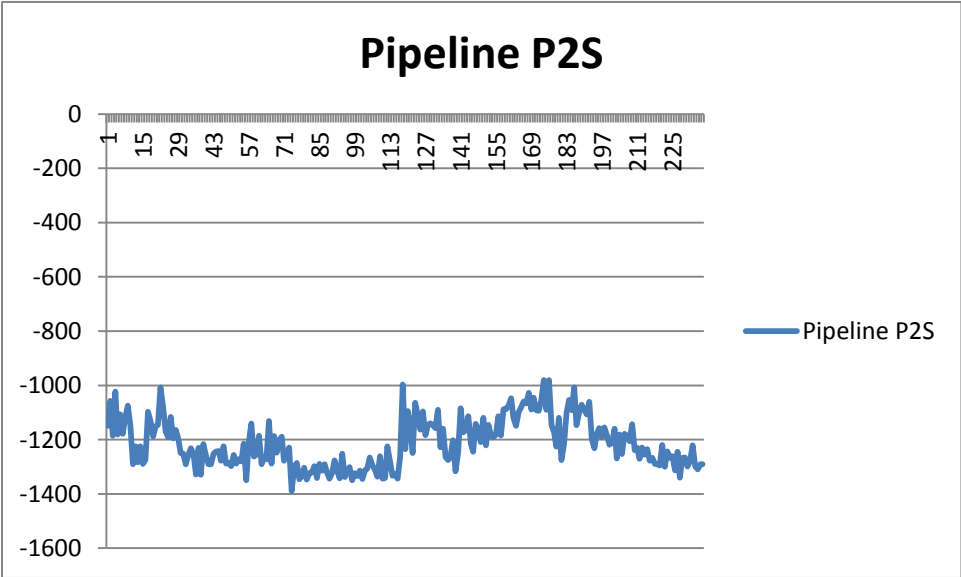


Figure 1 – Junction box with solid state decoupling device and monitoring unit

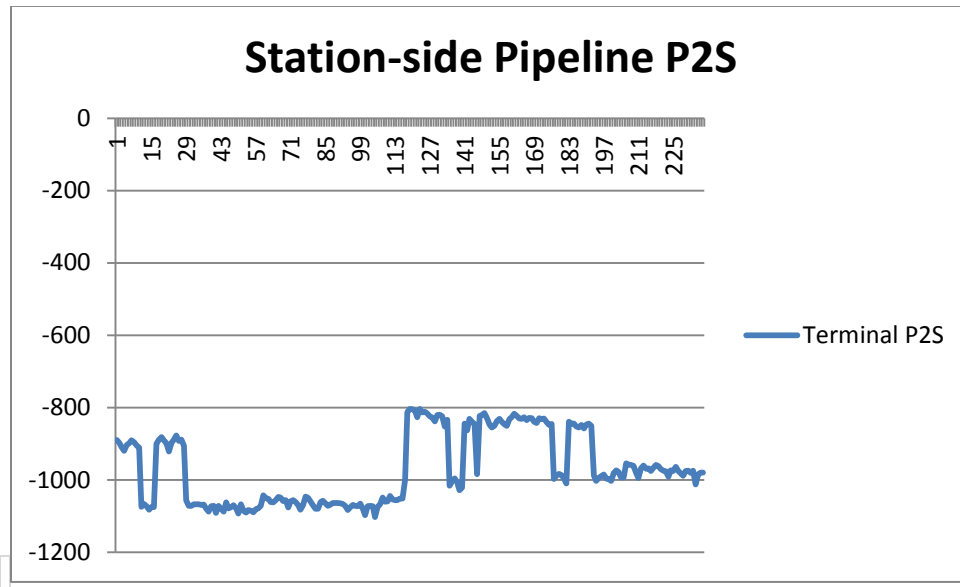
The monitoring device was configured to measure DC “On” voltage potential, DC “Off” voltage potential, AC voltage potential, AC current density, and DC current density from the transmission pipeline. Additionally native DC voltage potential and the station-side pipeline voltage potential were measured. The monitoring unit was configured to obtain measurements at four hour intervals and store them to internal memory. The device was configured to report to the web interface every two weeks. Periodically the stored data was downloaded to the web server as an Excel file for analysis and archiving. Figures 2, 3, and 4 display readings recorded at four hour intervals over a five week period.



**Figure 2 – Pipeline AC voltage potential measurements
(AC volts vs. 4 hour interval counts)**



**Figure 3 – Pipeline DC voltage potential measurements
(mVDC vs. 4 hour interval counts)**



**Figure 4 – Terminal DC voltage potential measurements
(mVDC vs. 4 hour interval counts)**

The charts indicate AC voltage is below 0.45 VAC, though a great amount of fluctuation is displayed even at these very low voltage levels. A comparison of the DC voltage potential measurements from the pipeline and the terminal show no direct correlation, indicating isolation of the cathodic protection current on the two structures.

Case Study 2

The second case study was conducted at a custody transfer point supplying natural gas to an electric power production plant. In this installation a decoupling device was installed at an above ground isolation flange. AC current density was measured as high as 24 amps per square meter at this location and the grounding system for the induced AC was on the power plant side. The decoupling device used was a PCR allowing current flow from the transmission side to the power plant side. In this installation 2 monitor systems were used, each configured to measure AC and DC voltage potential, DC “Off” potential, AC current density, and DC current density. The critical values were the AC density and the DC voltage potentials. The AC voltage at this location was well below the 15VAC standard, but current density measurements peaking above 20 amps per square meter were of some concern from a corrosion threat perspective. The DC voltage potential measurements provided indication of isolation of cathodic protection current. Figures 5, 6, 7, and 8 are daily measurements of AC density and DC voltage potential from both sides of the isolation flange, taken over a 6 month period from April 2014 through September 2014.

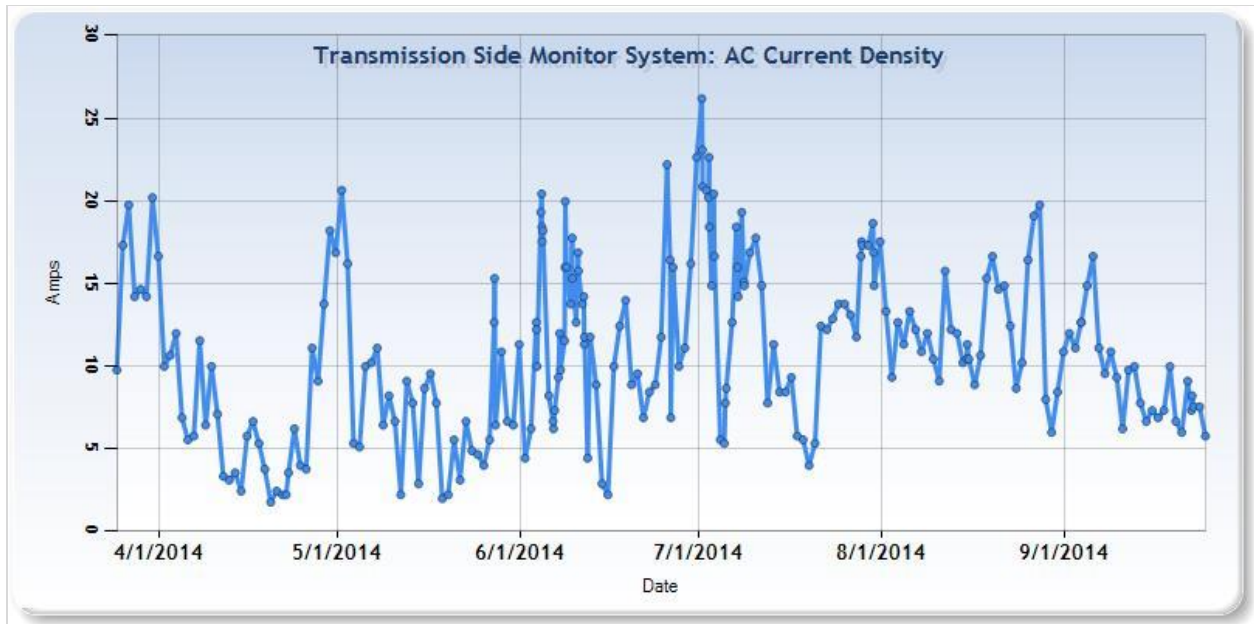


Figure 5 - Transmission pipeline side AC density measurements (A/m²)

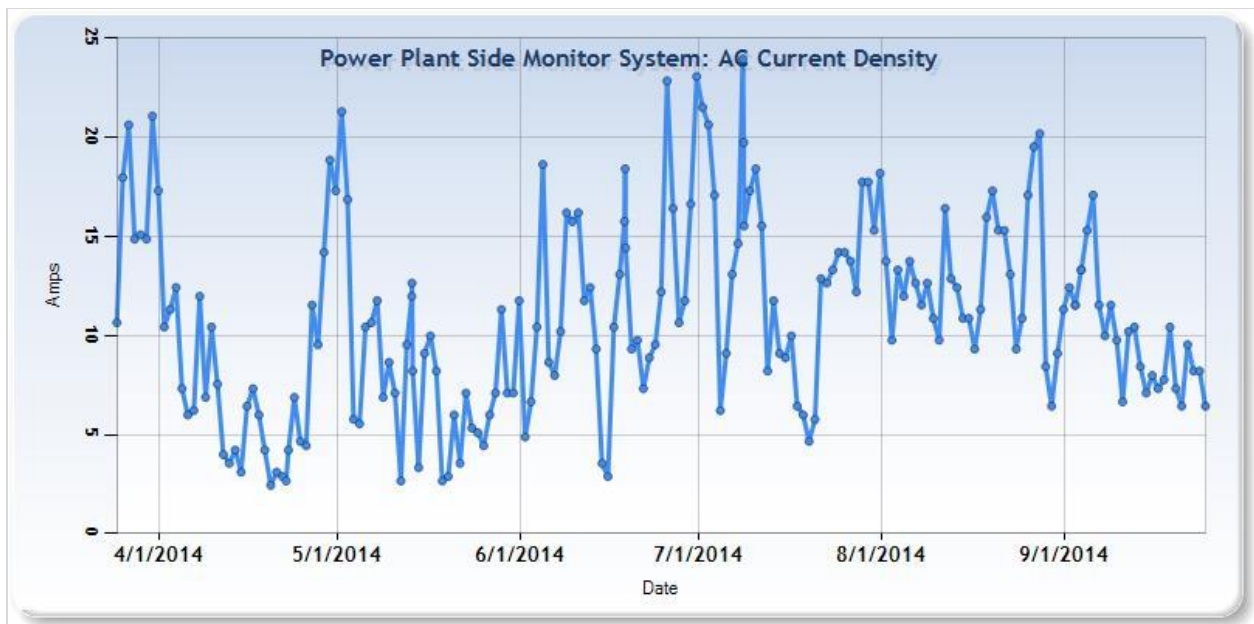


Figure 6 – Power plant side AC density measurements (A/m²)

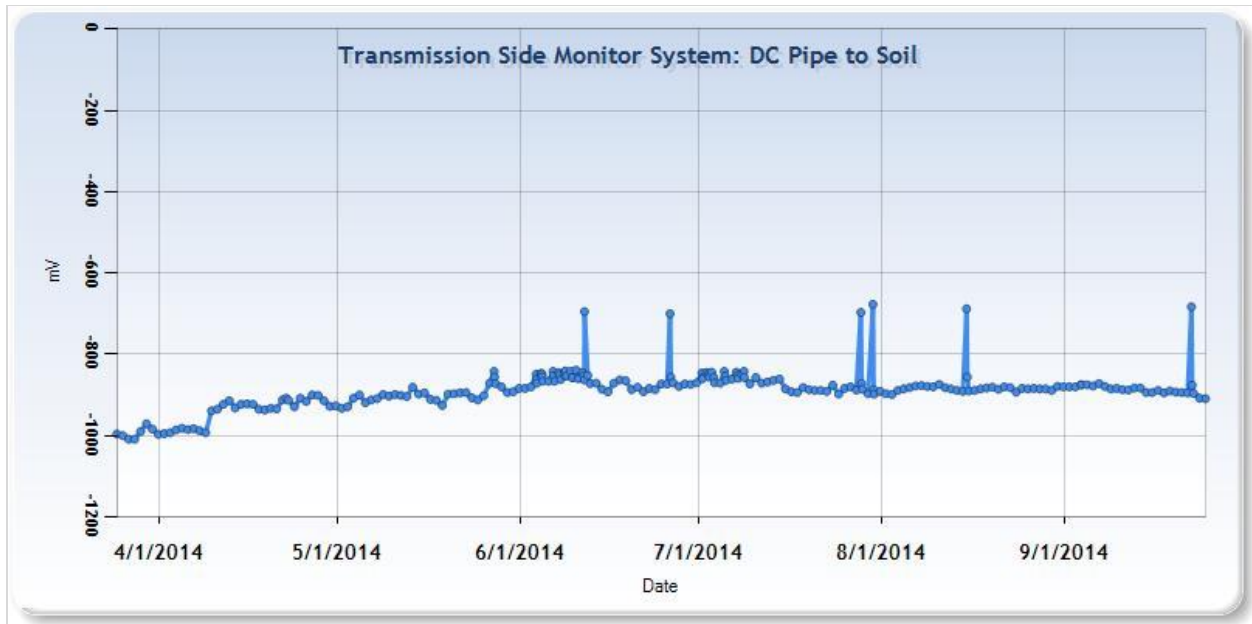


Figure 7 - Transmission pipeline side DC voltage potential measurements

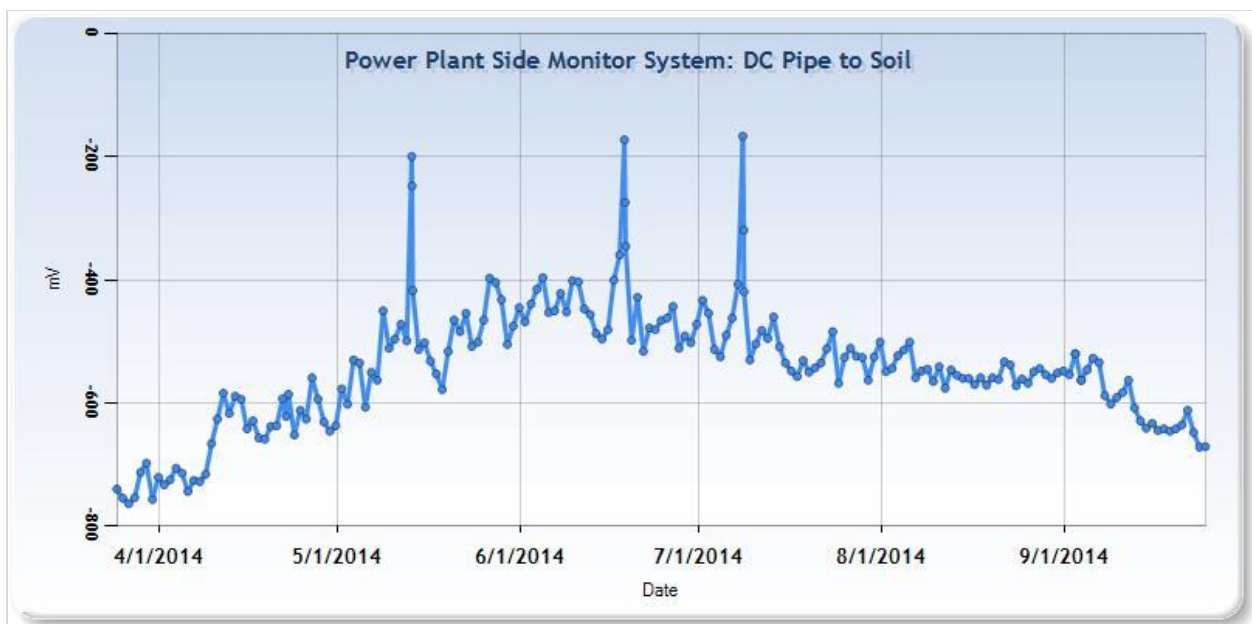


Figure 8 – Power plant side DC voltage potential measurements

Comparing the AC density measurements from the two sides of the isolation flange clearly demonstrates that the AC current is passing through the PCR device from the transmission pipeline side to the power plant side with the measurements being nearly identical. The DC voltage measurements taken over this same period show substantially different potentials on each section, indicative of effective cathodic protection isolation at the flange.

Summary

If a failure occurs at an isolation flange it may present risks to the integrity of the pipeline operating system. As such, locations of electrical isolation should be monitored and maintained with the same level of importance as any other critical device in the cathodic protection system. The regulations would indicate the isolating point should be checked for proper operation at least six times per year. Undesirable induced AC on the pipeline presents an immediate risk as a safety hazard if voltage levels exceed 15VAC. The primary purpose of installing an AC bond across an isolation flange is to provide a path to ground for induced AC, ground faults, and surges. In this regard a compelling case can be made for inspecting these bonds at more frequent intervals due to the concerns with pipeline integrity in the case of failure. Often these bonds are located at remote locations, unmanned stations, custody transfer points at secure locations (power stations, airports, etc.) making it difficult to routinely access the location for inspection.

The measurements recorded using remote monitoring devices that have been installed at these case study locations demonstrate an effective method for monitoring the performance of the decoupling equipment and the isolation flanges on a continual basis. Additionally, all of this type of monitoring equipment includes multi-parameter alarm notification enabling the pipeline operator to be aware of any changes in conditions at the site that could be a threat to operating personnel or the integrity of the pipeline system. This ability to provide continuous site performance information, immediate notification of potentially detrimental changes in operational status, and to provide associated CP measurements for evaluation of pipeline integrity (“instant off” potentials, DC current levels, etc.) demonstrate this type of equipment to be a very cost-effective and convenient alternative to frequent physical site visits for validating proper decoupling device operation.