The need for real-time data is affecting the ability to provide cathodic protection (CP) to pipelines. The connection of electronic equipment required for remote pressure monitoring, metering information, valve operators, and other functions creates a direct short from the CP on the pipeline to the electric power company alternating current grounding system. In essence, the CP system now must protect not only the pipeline, but also a sizeable bare copper grounding grid. This problem creates pipe-to-soil potentials that may not meet the desired criterion. This article covers the use of decoupling devices to remedy this problem.

As the demand for real-time data has increased so that the operator or customer can monitor numerous data inputs, electronic monitoring has become common. This may be continuous monitoring or on-demand systems, dial-up or supervisory control and data acquisition (SCADA). Electronics are used for a variety of purposes, including monitoring pressures, temperatures, gas volumes, valve positions, operation of odorization equipment, and numerous other processes. The data must initially come from some type of transmitting device that is converting the pressure or meter pulse, for example, to an electric signal. These systems are usually low-voltage direct current (DC) configurations that send signals back to a main data collection point. From here the data are transmitted back to the operator, where they are viewed or recorded.

In this facility, the DC cathodic protection (CP) is connected to the alternating current (AC) grounding system via conduit, wiring, grounding bonds, or piping. The facility AC safety grounding system is also bonded to the local power utility grounding system. The resulting effect upon the DC CP system includes low potentials and excessive current. The AC and DC systems must be separated to maintain necessary CP levels; safety grounding must also be maintained within the facility, according to the U.S. National Electrical Code, and bonding to the utility grounding system must be kept intact. This conflict may appear insurmountable when designing facilities for natural gas systems, but equipment and installation procedures for “decoupling” the facility ground from the utility grounding system are readily available and straightforward. Decoupling involves DC isolation combined with simultaneous AC continuity.

Experience has shown that the facilities are constructed by engineering and design teams who may not be aware of CP issues. The corrosion technician may have to troubleshoot low potentials after the construction has occurred. The best way to head off this problem is for the CP personnel to be part of the design process. If this education process can occur, the design can meet all the regulations by the various agencies and company disciplines.

A Methodical Approach

When evaluating a facility for an electrical short, it is practical to do some investigative work in the field and in the office to determine the potential cause. It is important not to overlook the obvious when completing a field or office review. When visiting a facility, look at it as if it was the first time it has ever been inspected. It will also be very important to
document all the findings and take pictures as necessary to complete an investigation. A diagram may be very helpful for future reference. This may also remind one of things observed at the facility that other technicians can be asked about later, such as new construction activity.

The site evaluation may include items such as:

- Verifying the operation of the equipment, such as meters, half-cells, and leads.
- Taking multiple pipe-to-soil (P/S) readings throughout the facility, including buildings, ground rods, and conduit, as well as the pipe.
- Observing new construction activities such as transmitters, isolation flanges, or electrical boxes. Also, look for any new construction on a customer facility if it is a shared site location or has shared equipment.
- Reviewing the electrical supply. Is it purchased power, solar power, or some other type or combination?
- Documenting the type of electronics and transmitter locations at the facility.
- Completing a close interval survey of the affected pipeline. This could be a simple “on” survey or an interrupted survey to help determine problem areas.
- Using a pipeline short locator to help determine the short location. Check all piping, ground rods, building interfaces, conduit, and electrical fuse and disconnect locations, transmitters, customer locations (if applicable), or any other locations with indications of a potential short.
- Working with the local electrical power company to disconnect the grounding connections temporarily, including the neutral coming into the facility. Note the station and pipe CP readings before and after and document the results. Readings that shift more negative may indicate that a short existed to the power company prior to the test. A permanent decoupling method described later can address this issue.

**Troubleshooting Existing Facility Electrical Shorts**

Most low CP potential issues arise from the retrofit of existing facilities where there are transmission-to-distribution or transmission-to-transmission exchange points, which utilize data acquisition equipment or grounded AC equipment. Equipment on, or connected to, the pipeline may bond the CP system to the facility grounding grid, and ultimately to the power company grounding system. A pipeline that was once isolated from ground may now have multiple bonds because of AC-powered devices, communication systems, or added grounding rods. Since grounding codes dictate that various utility services must be bonded, the CP personnel were left with inadequate CP.

Because older grounding systems are typically copper, the pipeline’s CP system attempts to protect it. This has two very detrimental consequences; because the
CP is now protecting structures other than the pipeline, a much larger amount of current may be needed to protect the pipeline structures. This can be a significant drain on the pipeline’s CP and can potentially reduce P/S potentials below the desired criterion. It also has an economic effect on the pipeline operator as the amount of power needed to protect all these additional structures is costing the operator more money. Second, a polarization film is created on the bare copper grounding rods. This film can raise the resistance to earth for the ground rods and could cause personal and equipment safety concerns.

Because of all of the unknown factors involved in the retrofit of older stations that show low potentials, a solid state decoupler has been successfully used in remediation of this bond to the power company grounding system. Installed by the power company, the decoupler effectively maintains the AC safety bonding of the grounding systems, while isolating the CP on the facility and pipeline from the power company’s extensive copper grounding system. In some cases, the decoupler may be able to perform the same function, but be located on the pipeline operator’s electrical system. The applications depicted in this article are of decoupling installed by the power company.

This decoupler is a solid-state DC isolation and AC coupling device, with the characteristic of blocking DC current flow under normal conditions, while conducting any AC current. When an AC fault or lightning event raises the potential of the pipeline facility ground or the power company ground, the decoupler instantly switches to the shorted mode and bonds the systems together for safety. When the event is over, the device automatically switches back to the DC blocking and AC conducting mode. Because the device is fail-safe (shorts if it fails) and has been tested and UL listed as an “effective grounding path,” the electrical codes are satisfied.

Usually, the decoupler is purchased by the pipeline company and supplied to the power utility for installation, after consultation with them about the technical issues involved. The main rating for the device is the AC fault current value, which is chosen to exceed the power company’s primary distribution system phase-to-ground AC fault current magnitude and time duration. Sized to this value, the decoupler ratings will not be exceeded, and the device may operate an unlimited number of times. Figure 1 shows a typical schematic of the decoupler location. Figure 2 shows a photo of a pole-mounted device.

The decoupler is connected between the power company’s grounded neutral and the pipeline facility’s secondary neutral at the transformer, and can be installed at pole-mounted or pad-mounted transformers. System voltages are irrelevant, as the decoupler is only installed in the safety bonding system, not in series in the neutral or any power conductor.

<table>
<thead>
<tr>
<th>Location</th>
<th>Before Installation (V CSE)</th>
<th>After Installation (V CSE)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Station inlet piping</td>
<td>-0.872</td>
<td>-1.188</td>
</tr>
<tr>
<td>Station outlet piping</td>
<td>-0.892</td>
<td>-1.208</td>
</tr>
<tr>
<td>Heater piping</td>
<td>-0.891</td>
<td>-1.171</td>
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<tr>
<td>Existing meter run</td>
<td>-0.855</td>
<td>-1.209</td>
</tr>
<tr>
<td>New meter run</td>
<td>-0.913</td>
<td>-1.171</td>
</tr>
</tbody>
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Cathodically Isolated Segment—Case History 1

During an annual P/S survey, a P/S reading was noted to be below the desired criterion of −0.850 V to copper/copper sulfate (Cu/CuSO₄) electrode (CSE), −0.702 V, at a metering station. The P/S reading at the station inlet valve was −1.265 V CSE. The location where the potential was low was where a section of pipe had been inadvertently isolated to protect the electronics for the gas measurement (Figure 3). A 25-ft (7.6-m) segment of below-grade pipe became isolated from the main impressed current CP system. Without the additional isolation flanges, the entire station and pipeline could not meet the desired criterion. To boost the P/S potentials, five 17-lb (7.7-kg) magnesium anodes were connected to the isolated piping first. Because of the direct short to the electric utilities, these were not effective either, as the anodes were trying to protect the grounding system, too. If the grounds were disconnected at the electric panel, the potentials could be raised, but this sacrificed the grounding protection for the measurement equipment. It also became a personnel safety issue, as an employee may be injured if fault currents were present and the employee became the path for the discharge of this current. A decoupler was installed at the transformer, allowing the anode bank to protect the isolated segment. The final reading for this segment of pipeline rose to −0.984 V CSE after the installation of the decoupler and the station inlet valve remained at −1.263 V CSE.

New Electronic Equipment Installation—Case History 2

When lower than historical P/S potentials were noted at a natural gas distribution metering station during the annual P/S inspection, an investigation followed. Readings at numerous locations around the station were taken during the investigation and a newly installed bypass gas meter was discovered. The installation had taken place during the summer. The new gas meter and electronics had been installed after the previous year’s potential survey. Using a short locator connected to the pipeline, the instrument identified a short at the transmitters associated with the new installation. The short continued on to the electronics building and electric power distribution panel. This connection tied the pipeline to the power company grounding grid. Because the new meter and transmitters were installed inside of the existing meter and regulator building, additional remediation was needed. There was no safe way to isolate the new meter without causing an arcing potential inside a closed hazardous location, so isolation flanges were not used. The best solution was to install a decoupler mounted at the transformer. The P/S potentials shifted back to the historical protection levels (Table 1).

Conclusions

As the need for real-time data is necessary in the pipeline industry, corrosion personnel must be diligent and active in the process within their company. If a methodical approach to troubleshooting is followed and technicians are actively involved in the design process, the CP system should not be adversely impacted. One very effective method for ensuring CP levels is the use of a properly sized decoupler. These units allow the gas pipeline, electronics, and grounding systems to coexist within the facility while providing the necessary electric fault protection and CP levels. This unit can be a part of the initial design or retrofit of existing facilities with the same positive results.

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Reference


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