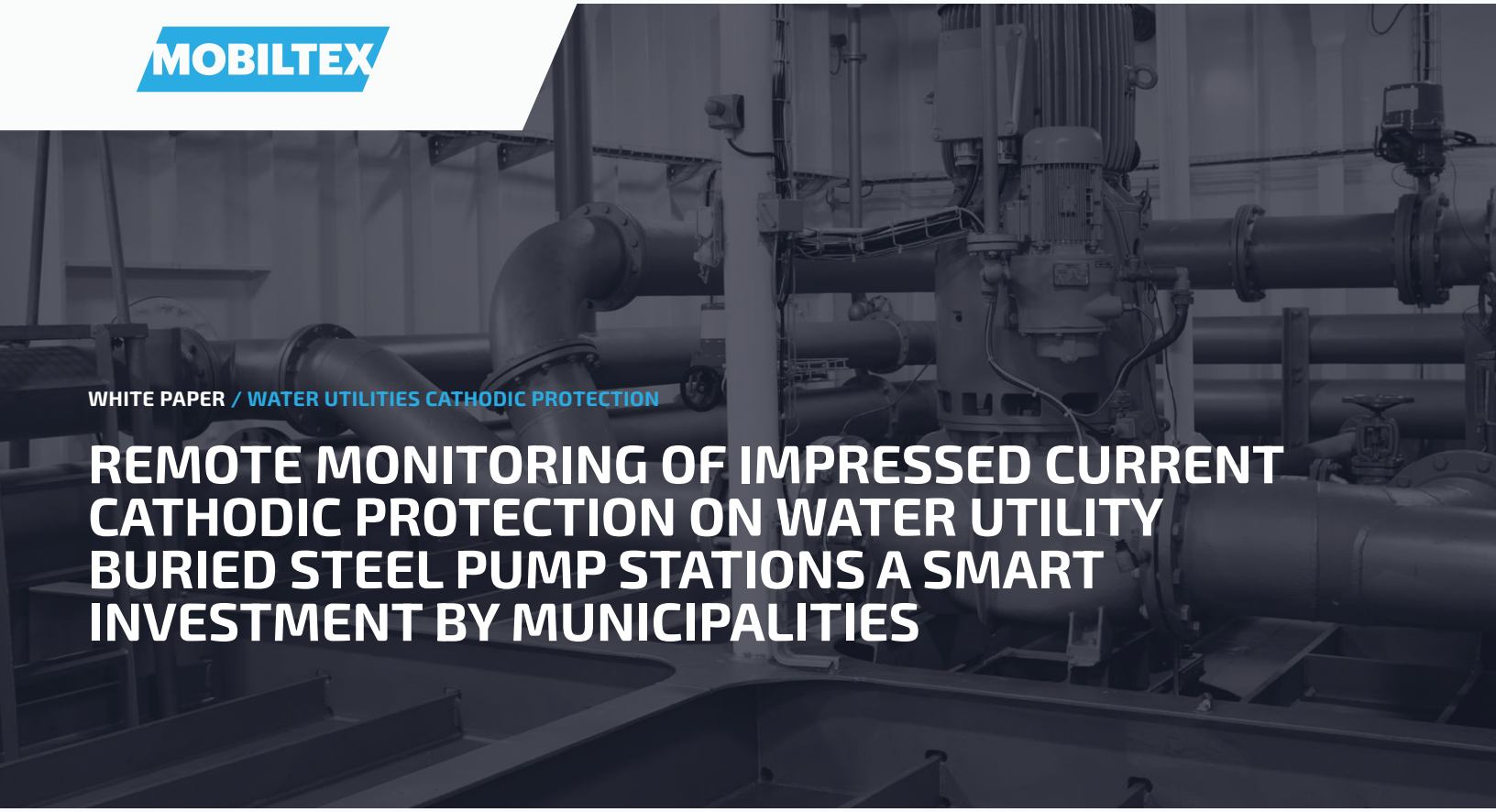
MOBILTEX



WHITE PAPER / WATER UTILITIES CATHODIC PROTECTION

REMOTE MONITORING OF IMPRESSED CURRENT CATHODIC PROTECTION ON WATER UTILITY BURIED STEEL PUMP STATIONS A SMART INVESTMENT BY MUNICIPALITIES

Pumps, piping, and electronic control systems within buried prefab steel pump stations are key components of every municipality water infrastructure system and represent significant investments for these operations. Effective corrosion mitigation is crucial to maintain the structural integrity of these assets, as well preventing moisture ingress and ensuring optimal chamber environmental conditions.

For decades governments around the globe have developed comprehensive regulations ensuring buried pipelines in the energy industry meet a wide range of critical standards. These regulations targeting the oil and gas industry are designed to mitigate environmental and safety risks associated with corrosion damage and leakage, but they also have the added benefit of significantly extending the active lifetime of protected oil and gas infrastructure, thereby significantly reducing replacement and deferring upgrade costs. These obvious benefits have been recognized by a number of other industries, including municipal water and sewer utilities, in order to extend asset lifecycles, drive down repair or replacement costs, prevent water and sewer service interruptions, and improve overall safety for the communities they serve as well as their technical teams working in the field. Municipal water and sewer utilities have long been faced with the challenge of preventing external corrosion on subgrade prefabricated steel pump stations. The operational repercussions from an avoidable corrosion failure are significant not only due to the potential downtime for the critical infrastructure functions, but also these structures contain sophisticated electronic control systems that can be damaged, and more importantly worker safety can be compromised.

It should be noted that sacrificial anodes are already commonly installed alongside water mains, pump stations, and other important water utility infrastructure, but it comes as no surprise that leakages and corrosion failures inevitably occur on these structures statistically much sooner than their oil and gas equivalents. Observations from data collected by Schramuk [1] have shown that water pump stations protected by galvanic anode cathodic protection (CP) systems alone typically need to be repaired or replaced after a relatively short service lifetime of only five to seven years. On the contrary, well-maintained oil and gas pipelines with a suitable integrity program regularly have lifetimes in excess of 20 years. It is estimated that 25% of infrastructure failures due to corrosion could be easily prevented using established protective measures like impressed current cathodic protection system [2]. Addressing these and other corrosion issues in water services could extend steel structure lifetimes to over 100 years with proper maintenance activities using the latest techniques and technologies [2].



This whitepaper explores why there is such a pronounced difference in service lifetimes between basic and advanced corrosion protection systems on municipal and utility infrastructure, and how these industries can realize significant long-term benefits from adopting the same technologies and techniques used by oil and gas system operations. While some advanced technologies and monitoring solutions have historically been viewed as cost prohibitive for municipal water applications, this is no longer the case.

EFFECTIVELY PROTECT WATER SYSTEM INVESTMENTS

Every prefabricated water utility pump station consists of a carbon steel pump chamber which houses the associated pumps and piping within a secure and protected environment. Moisture control is the primary challenge within this structure and as such complex air-circulation and dehumidification systems as well as critical drainage system designs are employed to maintain a constant environmental condition to protect advanced electronic controls systems. These important system components provide complete status and control for operators to the buried pumping system, and therefore reduce the need for direct access by field personnel into the stations themselves, except to perform routine maintenance.

There is a significant investment made for each and every pump station installation, with each fully equipped station easily ranging from $400k - $600k USD [1]. To mitigate external corrosion, it is common practice to apply specialized coatings to the exterior to the metal structure in the pump chamber as well as a Cathodic Protection (CP) system. This coating will prevent water as well as oxygen from direct access to the metal surface, mitigating corrosion. However, the reality is that no coating is perfect, and often installation defects and third-party damage occurs. In fact, when these damaged coating locations (referred to as holidays) are combined with CP systems it can actually contribute to significantly accelerated corrosion failures in the structure. The very protection from DC corrosion attained by applying CP can lead to accelerated AC corrosion in areas under the influence of induced AC from power lines because of the AC current concentration at the small coating defects. This can become even more destructive with the addition of stray current from high voltage DC power lines and light rail transit systems.

Given the nature of these subgrade structures and the necessary environmental conditions required within the chamber to protect the system components, even small failures left undetected for long periods will lead to compromised integrity of the steel structure and moisture ingress, and in some cases even structural catastrophic failure. Unfortunately, statistics show this has historically occurred more frequently in the municipal and utilities sectors, but this trend is changing due to new forward-thinking teams and more strategic investments.

MODERNIZING CATHODIC PROTECTION

CP systems can be divided into one of two types, either sacrificial anode cathodic protection (SACP) systems or impressed current cathodic protection (ICCP) systems. The main difference between them is that galvanic anode CP systems rely on the innate electrochemical potential of a more active metal (“anode”) to corrode in place of a metal with a more noble electrochemical potential (“cathode”), which is the structure to be protected. The galvanic anode is a consumable (sacrificial) and will provide protection, but can be negatively impacted by external sources such as seasonal variations as well as stray current sources, like high voltage power lines and transit systems common in urban applications. ICCP systems on the other hand use an external power supply, commonly a rectifier along with the anodes, to power the electrochemical reaction. By not relying on the electrochemical potential difference of metals to drive the reaction, ICCP systems can supply significantly more protective current to a structure and can be effectively optimized with modern techniques and technology to ensure assets are effectively protected at all times in even the most challenging applications.

Standard practice for many pump stations and other water utility installations is to include a predetermined number of sacrificial anodes as dictated by the design and installation procedure. Anodes are typically installed during construction via a direct wire connection and then backfilled. If a test station connection is not installed with a direct wire connection prior to backfilling it is difficult to determine how the anode is performing over time, and it is not uncommon for anodes installed in this fashion to be damaged or



even cut off during the construction backfill process. These types of installations also frequently fail to account for different soil conditions, the final coating condition after installation, and a myriad of other factors which can all accelerate corrosion [3]. Without performing current requirement tests of a water utility structure after final installation, it is impossible to confidently identify the correct number of sacrificial anodes needed to protect a structure from corrosion. Additionally, these current requirements may change over time as coatings continue to breakdown and soil conditions change.

The best solution to the shortcomings posed by a conventional SACP system is a well-designed, maintained and monitored ICCP system. ICCP systems are a practical solution for large, steel structures like buried pump stations because providing the necessary amount of current using a sacrificial anode CP system often takes an excessive number of anodes [1] and can present a number of challenges and limitations. By overcoming changing soil conditions, deteriorating coatings, and the limitations caused by large, complex structures, ICCP systems can often extend the lifetime of assets by decades when properly monitored and maintained.

CATHODIC PROTECTION RECOMMENDATIONS

ICCP systems are a practical option for cathodically protecting any large, uncoated structures. The most common rectifier design is a constant voltage rectifier. Constant voltage rectifiers have the advantage of being a simpler system, which makes them easier to troubleshoot and less expensive to purchase. They need to be regularly inspected in case rectifier adjustments are needed, often monthly, to maintain the proper current output as conditions change. The lower initial cost and simplified operation may still be a suitable option for some utility owners/operators depending on whether they can regularly send a technician to the rectifier site.

Constant voltage rectifiers can also be paired with remote monitoring to simplify these requirements by automatically collecting regularly scheduled measurements for technicians to review without needing to directly access the rectifier. This way technicians only need to be sent into the field when a CP system is operating outside acceptable limits or for other scheduled maintenance operations. The operator can be assured of continuously optimized CP protection, especially within challenging urban applications and during seasonal fluctuations.

An alternative is the constant current rectifier, which automatically adjusts voltage to maintain the required current output needed for protection of the infrastructure assets. More complex and thus more costly during initial purchasing, constant current rectifiers can adapt to changes in coating quality, soil conditions, anode depletion, and more to ensure the current required for meeting NACE standard protection criteria is maintained. These rectifiers generally require much less hands-on attention from technicians and also greatly benefit from remote monitoring systems to ensure they continue to operate properly and are accurately adjusting to the current requirements of the protected structures.

Installation of remote monitoring units (RMUs) to continuously monitor the structure to soil potentials of the steel structures for both SACP and ICCP can increase the chances of timely replacement of the sacrificial anodes, thereby eliminating the possibility of a non-functional CP system on a pump station for extended periods of time. Regardless of the type of CP system chosen or the class of rectifier, remote monitoring solutions are becoming an increasingly common way to ensure an asset's long-term protection from corrosion and to significantly decrease maintenance costs associated with routinely checking the operation of the associated CP systems.

REMOTE MONITORING OPTIONS

Next-generation RMUs are capable of reliably collecting and transmitting an assortment of data, direct from the field, allowing for remote management of your network from any web-enabled device through the powerful cloud-based platforms. The major advantages of deploying a CP remote monitoring system are the assurances of ICCP system uptime, increased data collection to optimize asset protection in the most challenging applications, significantly reduced costs associated with CP maintenance activities, and improved overall safety for personnel and the community.

RMUs give you regularly scheduled updates on the status of CP systems, meaning that if an issue occurs, it can be addressed



immediately instead of risking irreversible corrosion damage between scheduled inspections. This also means that scheduled inspections can be spaced farther apart, reducing labor costs associated with in-person inspections of certain assets and facilities. In addition, many RMU platforms have the capability to add complimentary sensor technologies for near real-time collection which can further enhance integrity program intelligence with valuable new environmental and condition data.

Another benefit realized is increased safety for field personnel that have historically been required to enter high-risk confined spaces or areas with hazardous atmospheres in order to take readings. RMUs ensure that inspections and repairs only need to occur when a problem is detected, eliminating the risk associated with conducting intermittent, in-person inspections. Depending on the location of the pump station and its entry point, operations can also realize numerous benefits from available robust subgrade RMU test stations in urban locations including significantly reduced cost and increased safety, eliminating the need for permitting and traffic-stops, efficient compliance with applicable corrosion standards, and optimizing CP performance and extending asset life.

CONCLUSION

In the United States alone, the replacement of water infrastructure most urgently in need is expected to cost $1 trillion USD over the next 25 years [4]. The buried steel pump stations associated with that figure are a significant part of the equation and will be major factors in this replacement cost. It is estimated that 35% to 50% of these repairs can be avoided with proper design, operation, monitoring and corrosion prevention [5]. While the sacrificial anodes that are commonly included with water utility installations can mitigate some corrosion over the short term, an impressed current CP system is the practical way to ensure truly long-lasting protection and drive down replacement costs. Suitable ICCP systems provide superior protection to assets and are often more cost-effective for large, buried structures in the long term. Combining SACP or ICCP with an advanced cloud-connected RMU remote monitoring system maximizes the effectiveness of your corrosion mitigation program, ensuring continuous operation at the intended settings while reducing risk, resources and costs associated with ensuring the integrity of these critical assets and satisfying regulatory requirements.

The MOBILTEX **CorTalk RMU1-SUB** and **CorTalk RMU3** remote monitoring devices are reliable and easy-to-install, and when combined with the advanced **CorView Cloud Platform** are effective solutions for automated acquisition of GPS and time-synchronized cathodic protection system data from your municipal water system assets.

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