AEGION KEEPS INFRASTRUCTURE WORKING BETTER, SAFER AND LONGER
BY PROVIDING CORROSION SOLUTIONS FOR PIPELINES, REFINERIES,
ABOVE AND UNDERGROUND STORAGE TANKS.

Our solutions include field joint coating applications
and pipeline inspection services for onshore and offshore
pipeline projects throughout the world.

We offer a full spectrum of AC safety and AC corrosion
detection and cathodic protection services. With thousands
of miles of pipeline protected, our proven solutions are
practical, cost-effective and specified to our clients’ needs.

Using the most current application methods and modern
extrusion equipment, we offer polyethylene and polypropylene
three-layer coating systems along with 5LPP and molded
GSPU insulation coating systems.

We also offer the world’s leading polyethylene pipe lining
systems for internally protecting against pipeline corrosion
and abrasion.

Aegion Coating Services
800.432.5914

The Bayou Companies
800.619.4807

Corrpro
800.CORRPRO

United Pipeline Systems
970.259.0354

www.aegion.com/corrosion-protection

AEGION® COMPANIES
Welcome Letter
Chief Technical Officer David Kroon recaps 2015.

Continuous Improvement Begins with Aegion’s Five Core Values
Quality Manager Jennifer Bean discusses how our values affect quality.

Corrpro On Board to Monitor and Maintain Florida’s Cathodic Protection Systems
Our professionals help keep Florida structures in working condition.

Corrpro Highlights Around the Globe
We provide CP protection to pumping station in The Middle East; Aegion employees win industry awards; Our impressed current system is used in aggressive environments; Corrpro conducts measurements on an HVDC line.

United Completes First Installation of New WeldTite™ EF Welded Connection
United Pipeline de Mexico breaks ground with its new welded connections.

Aegion Successfully Completes Deepwater Insulation Projects
Bayou Wasco provides insulation for offshore projects.

Aegion Coating Services Prevents Corrosion at the Field Joint
Aegion Coating Services now provides both internal and external robotic field joint coating.

Water Piping System Repair and Replacement at a Nuclear Facility
Fibrwrap and Fyfe take on pipeline rehabilitation at a nuclear facility using FRP.

Corrpro Conducts FEED Project Report in Alaska
Corrpro works with CH2M Hill to provide a comprehensive report on the Alaska Stand Alone Pipeline.

New Solutions for Small-Diameter Pressure Pipes
Insituform and Fyfe team up to bring a new product to market.

Cathodic Production Design for Multiple Well Casings
Corrpower International develops new software program to design CP systems for well casings.
2015 was a significant year at Aegion. Our focused efforts and dedicated people weathered the market headwinds created by low oil and gas prices, leading to a dramatic reduction in capital projects and maintenance spending by our clients.

Our business alignment with three platforms has served us well. This past year, we merged CRTS and CCSI into Aegion Coating Services to better serve our pipeline customers by providing both internal and external robotic coating for field joints (page 12). We also expanded our Energy Services business with the acquisition of Schultz Mechanical Contractors, Inc. Schultz offers construction, maintenance and turnaround services to oil & gas clients in the upstream, midstream and downstream markets. Affiliated with the building trade unions in California, Schultz allows Aegion Energy Services to address its customers’ needs to meet new state labor requirements.
SAFETY FIRST

In 2015, the Aegion Corrosion Protection platform repeated its excellent safety performance with a LTIR of 0.00. We have a best-in-class safety culture and continue to improve.

Our President and CEO, Chuck Gordon, introduced a set of new core values to reinforce safety and other important ideals. You can read more about these values and how they related to quality on page 4.

INDUSTRY INVOLVEMENT

Support and interaction between the business units is growing at an even faster pace this year as we develop and bring to market advanced solutions for our customers. Our technical teams regularly share information and support each other in their R&D efforts. We all continue to be active in developing industry standards, serving on technical task committees, presenting at conferences and publishing articles in technical journals. My personal involvement is primarily with PRCI International, AWWA and NACE International, which includes participation on the technical advisory panel for the IMPACT study.

We have advanced our technology and performance in many ways.

- Aegion continues to recruit, hire and train the best people in the pipe protection business. This unwavering focus guarantees our success.
- Aegion continues to build relationships with our technology partners to stay abreast of new materials and emerging technologies.
- The Aegion stage gate R&D process has been fully implemented across all business units, resulting in enhanced resource allocation and accelerated project completion.
- Aegion Coating Services completed development and commercialization of an automatic liquid coating ring that features quality and speed of application and overspray recovery.
- Aegion Coating Services introduced advanced robotics for coating internal field joints with improved inspection technologies.
- Aegion Coating Services, with the support of Corrpro, installed a full-scale test site with pipe surrounded by foam trench breakers to demonstrate that cathodic protection current does reach a pipe surface encapsulated in the polyurethane foam.
- Bayou’s investment in plant upgrades and process improvements for concrete weight coating as well as conveyors and handling equipment at its anti-corrosion coating plant enhances safety and efficiency.
- Bayou designed and commenced construction of a new Advanced Coating Facility for the application of ultra-high temperature anti-corrosion coatings and thermal insulation.
- Bayou has installed a new pipe bend test apparatus for testing deepwater insulation and has a new quality control laboratory under construction. (page 10)
- Bayou Wasco successfully executed two projects for deepwater flow assurance coatings using both ACS™ GSPU and ACS™ 5LPP.
- Brinderson introduced improvements to its program management and quality systems including PerformanceTrak™, TimeTrak™ and DelayTrak™.
- Corrpro advanced the technology, instrumentation and service offering related to AC interference and AC corrosion of pipelines.
- Corrpro performed an R&D project to demonstrate the effectiveness of vapor corrosion inhibitors (VCI) protection systems for tank bottoms, with and without cathodic protection.
- Corrpro designed, built and deployed remote monitoring and control systems for cathodic protection power supplies.
- Fyfe developed, tested and performed pipeline rehabilitation and strengthening projects with advanced materials for strength and severe service, including projects in the nuclear industry. (page 14)
- Fyfe and Insituform are collaborating to create a thin, small diameter solution to lining pressure pipe. (page 18)
- Insituform introduced improvements to its cured-in-place pipe (CIPP) trenchless pipeline rehabilitation solutions for both gravity flow and pressure pipes.
- United successfully incorporated its patented welded connection in major pipe lining projects, eliminating the need for flanged connections. (page 8)

During the first few months of 2016, we have continued to support R&D efforts to advance our product and service offering with new materials and emerging technologies. We have some very exciting projects underway and look forward to the year ahead.

Sincerely,

David Kroon, P.E.
Chief Technical Officer
Aegion Corporation
Aegion’s employees take pride in ensuring that all customers are satisfied with our products and services. In line with this ideal, in 2015 Aegion introduced a set of five core values:

- **ZERO INCIDENTS ARE POSSIBLE**
- **DO WHAT’S RIGHT**
- **WE SOLVE PROBLEMS**
- **RESULTS MATTER**
- **BE BETTER**

With these values in mind, we strive to improve all processes from product development to project closeout. Through this continuous improvement process, many of our companies have achieved certification to the ISO 9001:2008 standard.

**2015 QUALITY RESULTS**

- The Bayou Companies surpassed the 5-year mark for continued ISO 9001:2008 certification. They have initiated upgrades to the Powder Storage and Quality Control Laboratory (to be completed in early 2016).
- Aegion Coating Services obtained ISO 9001:2008 certification and in the first year of issuing surveys during project closeouts, they received a perfect score of 100 percent customer satisfaction.
- Corrpro US and Middle East have been certified to the ISO 9001:2008 standard for more than three years.
- Corrpro Canada completed the initial ISO 9001:2008 certification audit at its Edmonton assembly location.
- Corrpro Europe achieved qualification in the Achilles Joint Qualification System (for supplying to the oil industry in Norway and Denmark).

There has been an increase in the awareness and commitment to quality across all of Aegion. Numerous locations are working toward ISO 9001 certification, including United Pipeline Systems and Corrpro Canada. It is the responsibility of every employee to ensure we produce high-quality products and services.
Structures in direct contact with coastal waters experience corrosion activity around the tidal and splash zone areas. Uncontrolled corrosion of reinforcing steel and prestressing strands in marine structures can decrease the life expectancy of a structure to a fraction of its design life.

Many of Florida’s coastal structures suffer from premature deterioration of substructure elements. The reinforcing steel or prestressing strands do not have a protective coating and overdriving of concrete piles during construction caused hairline cracks in the concrete that serve as a direct path for moisture, oxygen and chlorides to reach the reinforcing steel.

Faced with this deteriorating condition, the Florida Department of Transportation (FDOT) aggressively implemented a corrosion protection program to mitigate the corrosion process of substructure elements. Both impressed current and galvanic cathodic protection systems have been regularly installed since 1991, and as of today approximately 40 impressed current systems have been installed on coastal bridges on both the east and west coasts and throughout the Florida Keys.

Because impressed current systems require a low voltage DC power supply to be constantly on for the system to function properly, monitoring is required. The travel distance from the FDOT Corrosion Lab in Gainesville to various sites for monitoring proved overwhelming after a few years, so the decision was made to invest and install remote monitor units at all sites. Remote monitors allow engineers to access the rectifier and other equipment from anywhere with an internet connection.

As the number of installations grew, so did the number of remote monitors and the need to outsource the monitoring and maintenance of the systems. The FDOT awarded Corrpro a two-year contract beginning in July 2015 to perform this work. Under this contract, engineers from Corrpro’s Florida office perform the following scope of services:

- Monthly remote monitoring and reporting of all sites statewide
- Maintaining and upgrading the website for accessing the sites at [www.myfloridabridges.com](http://www.myfloridabridges.com)
- Visiting sites to maintain and upgrade equipment
- Developing and installing new remotely-controlled equipment such as cameras, weather stations, scour monitors, tide elevation, etc., that can be used by engineers to assess bridge conditions

Did you know? Corrpro manufactures and supplies the materials and equipment used today on FDOT impressed current system such as anodes, reference electrodes, rectifiers and remote monitors.
TUNNEL PUMPING STATION
by Marek Wartecki, Corrpro | Project Manager

Corrpro has recently been awarded a contract in the United Arab Emirates (UAE) to provide specific engineering services and supply equipment to meet the cathodic protection requirements of a high-profile pumping station project. The project involves construction of a deep sewer tunnel and supply tunnels to transport sewage from the city to a treatment plant located more than 30 miles away. The sewage travels by gravity through an underground tunnel to a pumping station with a pumping capacity of 30-40 m³/second. The underground pumping station receives raw sewage, then filters and treats the effluent at more than 300 feet below grade.

The metallic structures, including stop logs, penstocks, gates, guides, frames, screens, float grabs, valves and pipelines, are permanently submersed in a very corrosive environment. The selection of the processing equipment involved extensive studies relative to corrosivity and suitability to the severe environment. The sewage has chloride levels of 11 ppm, H₂S to 30 ppm and total dissolved solids reaching 3,000 ppm. At these conditions, crevice and pitting corrosion can occur on steel alloys.

The original studies recommended using super-duplex grade steel such as 14410, 14507 and 14501 (24-26 percent chromium, 6-8 percent nickel, 3-5 percent molybdenum) to offset corrosion. However, the cost of using super-duplex steel was evaluated and determined to be cost prohibitive. The use of stainless steel 316L in conjunction with cathodic protection was determined to be the preferred option.

316L stainless steel contains 16-18 percent chromium, 10-14 percent nickel and 2 percent of molybdenum, and in regular conditions can be susceptible to hydrogen embrittlement if exposed to excess levels of cathodic protection. Therefore, the cathodic protection system had to be designed to provide uniform current distribution and prevent over polarization of the stainless steel structures. In addition, the anodes, reference electrodes, cables and all supporting materials of the cathodic protection system had to withstand both sewage flow rates to 40 m³/second and the possibility of solid debris in the wastewater.

The impressed current cathodic protection design involved fourteen multi-channel transformer rectifier power supplies. The design proposed the use of titanium/mixed metal oxide (MMO) anodes installed in various configurations.

The system includes automatic potential controlled rectifiers and the installation of numerous silver/silver reference electrodes to closely monitor the structure-to-electrolyte potentials of the structures. To avoid hydrogen embrittlement of the 316L stainless steel structures, the polarized potential will be limited to -400 millivolts relative to a silver/silver chloride (5M KCl) reference electrode.

AEGION EMPLOYEES RECEIVE DISTINGUISHED RECOGNITION

Two of our employees recently received prestigious industry recognition. We are proud of their service to Aegion and to the industries we serve.

Corrpro Senior Project Manager Dan Crabtree (shown to the left) received the Francis L. LaQue Memorial Award from the American Society for Testing and Metals (ASTM) in November 2015. This prestigious award was presented to Dan in recognition of his contributions to the G01 Committee on Corrosion of Metals for more than 15 years. Dan has 35 years of experience and has held several leadership positions, contributed to many subcommittees and was the primary contributor in the development of ten different ASTM standards. As an active member of NACE, he has also developed and conducted numerous corrosion control training programs.

Aegion’s Chief Technical Officer, David Kroon, was announced as the 2016 R.A. Brannon Award recipient in the February issue of Materials Performance. David has been an active member of NACE since 1972 and has served as chair of many corrosion-related technical committees of NACE and the American Water Works Association. He has more than 44 years of corrosion prevention experience and is also well-known as one of the founders of Corrpro.
FRONTRUNNER IN HVDC FAULT TESTING
by Boshra Momen Nejad, Corrpro | Project Engineer

Recently, Corrpro conducted detailed measurements on selected pipeline segments during staged fault tests on a high voltage direct current (HVDC) transmission line. Induced voltages on the pipelines in close proximity of the power line were measured by a utility company during the HVDC staged fault process.

Corrpro’s primary responsibility was to set up data logging units (PicoScope) at selected locations along the transmission line route. This made it possible to record the induced voltages on certain pipeline segments during staged faults on the HVDC powerline.

A pre-field laboratory test was conducted in order to ensure accurate calibration and functionality of the equipment prior to the actual staged fault field testing. In order to check the functionality of the digital triggering on PicoScope and choose an appropriate triggering level and methodology, a typical touch voltage waveform was used.

The measured waveforms were within the expected range for the general outline and frequency components. The measurement results were used for further validation or modification of the existing industrial HVDC guideline and verification of future modeling results.

CORRPRO’S IMPRESSED CURRENT CATHODIC PROTECTION SYSTEM FOR VESSELS
by Corrpro Engineering Team in Edmonton

Corrpro’s impressed current cathodic protection system is designed to provide effective corrosion protection from aggressive environments to internal surfaces of process vessels. Typically designed for upstream pressure vessels with abrasive process conditions and relatively high operating/design temperatures (typically 100-200°C), these conditions can make vessel coating application impractical, drastically increasing the surface area of metal exposed to harsh environments.

Additionally, the temperatures, sour conditions and presence of dissolved ions, such as chlorides, increase the current required to achieve adequate cathodic protection. These increased current requirements typically render sacrificial anode corrosion protection systems impractical.

Corrpro’s impressed current anode system is comprised of impressed current anode assemblies mounted to external flanges with current outputs controlled through specially designed rectifiers and junction boxes. The anode assemblies are comprised of three major sections: the impressed current anode, the barrel and the flange. The active (impressed current anode) portion of the assembly is composed of high silicon cast iron and protrudes into and typically across the interior of the vessel. Internal electrical isolation of the anode from the barrel and flange allows the anode to be consumed independently from the complete assembly. A specialized coating, rated for the vessel’s operating temperature, is applied to the barrel and flange portion of the assembly to enhance current distribution and extend the lifespan of the anode assembly.

MEETING REGULATIONS

Strict regulations are present in most jurisdictions with regards to the fabrication and operation of pressure vessels. To meet regulations, pressure containing components and fittings must be specially certified and registered in their corresponding areas. Previous anode assembly designs have included registration with the pressure vessel safety authority for Alberta, Canada. Experience with this registration process reduces the delay between initial consultation and site installation.

The complete system — including rectifiers, junction boxes and cable connections — is typically designed for use in hazardous areas within plant sites. Specially-designed rectifier and junction box combination units allow for individual adjustment of anode-driving voltages. This allows for finely tuned performance of the system in the varied process conditions and environments that are typically present in different sections of these vessels.

Installation of the system is completed under the direction of highly qualified and competent cathodic protection personnel. For efficient maintenance and repairs, the design lifespan of the impressed current anodes is matched to typical plant turnaround and shutdown intervals. The anode assemblies can be replaced as required while vessels are out of service.
United Pipeline de Mexico (UPM), a joint venture between United Pipeline Systems, Inc. (UPS) and Miller Pipeline de Mexico, recently completed the first field installations of United’s flangeless, continuous thermoplastic welded connections. The WeldTite™ EF connection system, developed for use with the Tite Liner® system, was installed in a series of pipelines for Pemex Exploración y Producción in Mexico. The welded connections were used in three pipeline projects that handle hydrated condensate, hydrated crude oil and produced water, providing a spectrum of applications for this technology.

For the past 20 years, United has installed thermoplastic liners for Pemex to protect pipelines from internal corrosion and abrasion. Thermoplastic liners can be a simple and cost-effective way to extend the life of valuable industrial assets. Over the years, many advances in technology have occurred and thermoplastic liner systems are now a mature and widely used technology. One critical aspect of a thermoplastic liner system is the connection of the lined sections. Until recently, installations depended on a flanged connection between lined sections. These types of connections have the potential of leaks. With the WeldTite™ EF flangeless connection, we are now able to effectively address this concern by offering a welded solution that provides a continuous thermoplastic connection throughout the pipeline.

PROJECT BACKGROUND

United recently implemented the new welded connection in several projects. These existing projects were already under contract and were programmed to be executed with traditional flanged connections. However, after discussing United’s welded connection alternative, the technical team at Pemex expressed its interest and enthusiasm for this alternative. As a result, a change order to install the new flangeless connection was approved by the engineering departments in all three regions — one at a gas production field, one at a crude production field and the third at a water injection plant.

Burgos Gas Basin Condensate Pipeline

The Torrecillas pipeline is a 6-inch pipeline running more than 13 miles. Carrying wet gas condensate from gas-producing fields, it operates at 290 psi and 95°F. Because of significant produced water content and condensation, the pipeline has
experienced numerous internal corrosion problems and leaks. Pemex contracted United to line a 1.6-mile low-lying section of the pipeline where they had repetitive leaks due to water settling. Pemex’s maintenance group chose this pipeline as a test bed for trying out United’s WeldTite™ EF solution.

**Aceite Terciario del Golfo (ATG) Basin Crude Production Pipeline**

The Furbero production field is part of the ATG oil production basin which, due to the maturity of the field, produces a significant amount of water along with hydrated sour crude. The Furbero 2048 production pipeline, operating at 175 psi and 104°F, was chosen as a trial pipeline to test United’s new flangeless connection solution.

**Jujo Basin Produced Water Pipeline**

The Jujo field is part of the Southeast crude production basin where, as with the ATG production line, there is a lot of water produced due to the maturity of the field. Several production wells in the Jujo-Tecominoacan field have been converted to water injection wells. One such line, the Jujo 23 injection line, would be pumping produced water at an elevated pressure of nearly 2,000 psi. This was a concern to the Pemex Engineering team, in particular if they used buried flanged connections in a high pressure injection pipeline. This concern presented an opportunity to test United’s flangeless connection on this new line.

**PROJECT PREPARATION**

United typically executes a turnkey service for its customers taking care of all aspects of a liner installation from the execution of all required steel work to hydro testing and re-commissioning. Even though these were the world’s first-ever installations of United’s WeldTite™ EF welded connection, one of the benefits immediately apparent to United’s crews were the productivity gains afforded in installing the steel couplings of the welded connection compared to a typical flange connection.

The project superintendent on the three jobs reported that everything from the weight of the connections to the setup, preparation and installation of the steel parts was easier. In fact, it took less than half the time and required less equipment and handling to install United’s flangeless connection system than it normally takes to line up, prepare and install a typical flanged connection. This translates into saved time and money.

**PROJECT EXECUTION, TESTING AND COMMISSIONING**

The installation of the liner required new tools, equipment and techniques developed by United in Durango, Colorado. The new methods worked flawlessly, considering this was the first installation of its kind. That said, United crews were able to quickly identify issues and adjust procedures to improve productivity, reliability and reduce workload for future installations. One such improvement was the development of a universal line-up jig to help crews line up pipe sections during steel work, as well as during the installation of electrofusion couplings.

In general, the installation of the Tite Liner® system and the WeldTite™ EF welded connection progressed well and United’s crews quickly were able to adapt and benefit from the ease of installation of the new flangeless connection. Due to the novelty of the system and to mitigate any installation errors or problems, United tested each individual section prior to connecting them together and then retested the system once the pipelines had been lined completely, assuring the integrity of the system before it was turned back over to the customer.

**CUSTOMER IMPRESSIONS**

There was a very positive general consensus among the various groups involved in the approval and supervision of the lining projects using the new WeldTite™ EF welded connection system. The acceptance of the technology was unanimous and will lead to a more widespread use of this solution in future Tite Liner® installations for Pemex. Marino Lopez Morgado, Maintenance Manager of Pemex Exploration and Production, commented that the one thing that made him “uneasy about liner installations was the need for leaving bolted connections buried underground.” While experiencing a leak in flanged Tite Liner® connections is extremely rare, United’s WeldTite™ EF welded connection has provided Mr. Morgado and Pemex complete confidence in United’s improved liner solutions.
Bayou Wasco Insulation (BWI), a joint venture between Aegion subsidiary The Bayou Companies and Wasco Energy Ltd., has recently completed insulation applications on two large deepwater projects, one with syntactic polyurethane insulation ACS™ GSPU and the other with syntactic polypropylene based insulation ACS™ 5LPP.

The Shell BC-10 Phase 3 project, requiring ACS™ GSPU application, marks the first successful insulation project run through the BWI facility located in New Iberia, Louisiana. The BC-10, or Parque das Conchas as it is also known, is a deepwater project located around about a mile of water off the coast of Brazil. Shell, the operator, has a 50 percent interest in the project. The fields were to be developed in several phases with subsea wells and manifolds and connected to a centrally located floating production, storage and offloading (FPSO) vessel. Phase I of the project was completed in 2009, followed by Phase II in 2013. Phase III, which included the tie-in of two additional fields was announced in July 2013. BWI was awarded Phase III with a scope of 90,000 feet of nominal pipe size (NPS) 8-inch pipe with one inch of ACS™ GSPU insulation, 4,000 feet of NPS 10-inch pipe with 4-inches of ACS™ GSPU insulation and 52,000 feet of NPS 10-inch with standard FBE. BWI commenced insulating pipe in mid 2014 at its new insulation facility and completed the project at the end of 2014. The flowlines have since been installed and connections are underway. The flowlines are scheduled to be in service by the end of the first quarter in 2016.

Following the Shell BC-10 project, BWI was contracted to run a small ACS™ GSPU job for Anadarko. The scope of work for that project was 2,150 feet of NPS 6-inch with 2-inches of insulation. This work was also completed prior to the end of 2014 with the line now back in service.

BWI’s second large insulation project was for Shell Coulomb Phase II requiring ACS™ SLPP insulation. The Coulomb subsea field is located offshore in the Gulf of Mexico in the Mississippi Canyon (MC) area, in water depths ranging from 6,300 feet to 7,800 feet. Coulomb Phase II Project consists of the installation of a new, single NPS 8-inch production flowline and steel catenary riser (SCR) connecting the NaKika host platform to the Coulomb drill center. The NPS 8-inch, 27-mile long production flowline was insulated to meet Shell’s flow assurance requirements. Also included in this project was the installation of a new, single NPS 4.5-inch gas lift line that was uninsulated, but coated with an anti-corrosion coating.

The Shell Coulomb Phase II contract was issued to BWI by Shell in May 2014 with work starting in the first quarter of 2015. The prequalification testing was followed shortly by production start-up. The project scope required internal diameter (ID) blast cleaning, application of three-layer polypropylene (3LPP — first through third layers) anti-corrosion coating followed by the application of the syntactic polypropylene insulation layer (fourth layer) and polypropylene jacket (fifth layer). Completion of the insulation scope of work occurred in late 2015 as well as commencement of load-out of insulated pipe to Subsea 7’s Spoolbase operation in Port Isabel, Texas.

NEW DEVELOPMENT IN DEEPWATER INSULATION TECHNOLOGY

Until now, there have been just two primary wet insulation systems for use with subsea pipelines and risers, polyurethane and polypropylene based systems. The driver for determining the correct solution between the two is design temperature of the fluid transferred within the line. Operating temperatures of less than 185°F typically receive polyurethane coatings, while temperatures above 185°F requires the use of polypropylene. Until recently, the upper limits of operating temperature of polypropylene were not an issue. However, there have been several projects over recent years that have pushed the use of polypropylene uncomfortably close to its maximum operating temperature range of nearly 300°F. In addition, the discovery of several wells in the Gulf of Mexico’s Norphlet play have found wellhead temperatures far in excess of what traditional polypropylene based wet insulation systems can handle.
Traditional subsea wet insulation systems consist of primer coat and one or more layers of insulation. The main purpose of the primer coat is to provide a surface in which the insulation layer or layers can bond. The secondary purpose of the primer coat is to provide an anti-corrosion function for the system if the normally sealed insulation coating is compromised. For both polyurethane and polypropylene insulation systems, fusion bonded epoxy (FBE) is used as the primer coat. However, current FBE technology limits operating temperature to about 300°F.

In early 2013, The Bayou Companies teamed up with Materia, Inc. to develop a subsea wet insulation system targeting operating temperatures of 350°F and greater. The efforts of a three-year development program have been successful, and a complete deepwater thermal insulation system consisting of an anti-corrosion layer, thermal insulation layer and an outer protective jacket has been developed.

This new system, ACS™ HT-200, has undergone a rigorous full scale testing program that includes industry standard testing such as simulated service, hot/wet aging, mechanical properties and water ingress, among others. The system has been slated for use in a major project in the Gulf of Mexico. To apply the new high temperature insulation system on a commercial scale, Aegion is constructing a production facility at its Bayou site in New Iberia, Louisiana. The 45,000 square foot facility will apply the anti-corrosion coating and the insulation under the same roof. The plant will commence operations in fall of 2016.

AEGION AND BAYOU CONTINUE INVESTMENT TO EXPAND SERVICE OFFERING

In support of Bayou’s continuing commitment to the deepwater insulation market, Aegion made several investments in upgrading Bayou’s facilities and service offerings. Additional equipment and upgrades recently added include:

- Installation and commissioning of a full-scale pipe bending test apparatus to be used in Bayou’s prequalification testing of insulation systems, R&D initiatives and will be offered to customers for their testing programs.

- Bayou’s concrete weight coating (CWC) plant saw upgrades to pipe handling and material reclaim for increased safety and efficiency of the plant, demonstrated on the Shell Amberjack 24-inch project in 2015.

- At the end of 2015, Bayou began construction on its advanced coating facility which will house the operations for our new ultra-high temperature insulation and anti-corrosion coatings.

- Bayou also began upgrades on its existing FBE facility to improve pipe handling safety and efficiency as well as improve the ease of cut-back installation for three-layer coating systems.

- Bayou’s commitment to quality has initiated upgrades to its powder storage and quality control laboratory, which will be completed in early 2016.

- The Port of New Iberia has also committed to upgrading the port facilities — including the replacement of the rail spur entering the Bayou pipe storage yard. This will improve Bayou’s ability to load-out pipe by rail and rounds out the cost-effective service offerings for handling their customers’ shipping requirements by either barge, truck or rail.

- In addition to completing the above-referenced capital projects in 2016, Bayou and Aegion will be pushing ahead with evaluations of further capital expenditures for ID painting and a mobile CWC plant.

As Bayou’s evolution continues at the New Iberia facility, we welcome the feedback, insight and guidance from customer audits and discussions. The investments made by Bayou and Aegion demonstrate they are partnering with new and existing customers to address customer needs and ensure the highest levels of service, quality and safety.
In January 2016, CRTS, Inc. and CCSI, LLC joined together to become Aegion Coating Services. The application of coatings to prevent corrosion in new pipeline construction is one of the many industry strengths of Aegion Coating Services. The Company’s primary focus is applying these coatings to the internal and external field joints of new pipelines during the construction process, while continuing to provide excellent service according to industry standards.

During the coating application process, it is important to follow NACE International’s recommendation that pipelines be internally coated “as an internal corrosion control measure.” 1 To protect external field joints from corrosion and mechanical damage, protective coatings are applied both internally and externally. Internal coatings extended to the field joints further enhance product purity and flow, while external coatings provide protection from the elements.

As simple as it sounds, the formula for best practice in corrosion management using coatings is not just the application, but the sum of the surface preparation, coating application and inspection that transforms coated surfaces into protected, defect-free pipelines. This formula applies to both internal and external field joint coating application. In addition to these quality standards, our process goes a step further: the internal and external field joint coating systems we use also protect equipment operators and the environment from exposure to hazardous material.

NPS REPLACEMENT PIPELINE
Aegion Coating Services was recently contracted to apply corrosion prevention coatings to internal and external field joints during the construction of a 36-inch nominal pipe size (NPS) replacement pipeline used to transport crude oil from tankers to an existing onshore transfer pipeline. The customer’s existing subsea line had reached its serviceable life, but with corrosion prevention coatings on all field joints, the replacement pipeline is now anticipated to last another 40 years.

The first stage of the project began with coating in a string yard located in the Port of Amsterdam and then completing the coating onboard a lay barge in northern England. All of the internal field joint coating was performed using remote-controlled robotic line travel equipment that includes a cleaner-vacuum (abrasive blasting and recycling) unit, liquid epoxy coater unit and inspection unit. Aegion Coating Services worked closely with the pipeline owner and contractor to meet unforeseen cold and wet weather challenges given that the project was completed during summer months.

After the internal field joints were cleaned, coated and visually inspected with onboard cameras, they were further inspected by a robotic unit to measure dry film thicknesses and detect any holidays and voids. This process allows the pipeline owner to identify and repair any defects on the coated pipeline. Daily production reports were signed by the contractor and applicator to ensure quality. Despite unexpected weather interference, field technicians worked efficiently and the internal field joint coating process stayed on schedule.

The second stage of the onshore/offshore project was handled by field technicians using the ACS™ Automated Liquid Coating Ring. Coating external field joints is a time-tested corrosion prevention method, but using automated equipment can be more efficient and environmentally-friendly than manual applications. External field joints were first blasted using the ACS™ External Blast Ring and ACS™ Blast Recovery System (BRS) units. These units incorporate recycling devices to help ensure there are no impurities left on the welded surfaces. The ACS™ BRS units also reduce customer costs by recycling the blast media and if requested, reusing it on the next external field joint.

The ACS™ Automated Liquid Coating Ring addresses several weaknesses found in manual spray or brush applications of external field joint coatings. Manual applications are prone to quality defects such as poor ratio control, variances in coating thickness, holidays, debris and foreign contamination.

1“Control of Internal Corrosion in Steel Pipelines and Piping Systems,” NACE SP0104-2006.
The ACS™ Automated Liquid Coating Ring also mitigates safety risks for employees, as traditional methods directly expose them to toxic chemicals. Manual spraying requires employees to wear Tyvek suits, rubber gloves and a respirator. With each layer of personal protective equipment, there is an increased risk of heat-related injuries. The ACS™ Automated Liquid Coating Ring combats these issues by eliminating some of these common safety and environmental risks.

Aegion’s commitment to safety is demonstrated in several features of the ACS™ Automated Liquid Coating Ring. One of these features includes fail-safe fasteners in case of power or air loss. First, the closing alignment requires minimal assistance from the operator to accurately position the Ring. Second, the Ring motion is completely automated — reducing the operator’s exposure to hazards like pinch points and line of fire. Customers and field technicians alike benefit from the stability of the frame design because it increases the pipe clearance when positioning the Ring.

After blast cleaning the field joint area, it is heated with 150 kW induction coils to reduce coating cure time. The ACS™ Automated Liquid Coating Ring can coat each field joint at 24 to 40 mils in less than a minute with just two to four rotations. During the coating process, the overspray recovery box captures roughly 95 to 99 percent of fugitive emissions. Coupled with a patent-pending material collection, our unique spray fan pattern provides quality coverage to the pipe surface.

Aegion’s internal and external field joint coating systems protect operators and personnel with safety features, protect the environment with recycling and recovery systems and protect the pipe itself from corrosion. Internal field joint coating is available for onshore and offshore projects using various equipment configuration capabilities, which are compatible with most fusion bond epoxy and liquid epoxy coatings.

For the major oil company customer on this project, protecting the pipeline from corrosion along its weakest links will, at a minimum, provide longevity, improved product flow, environmental diligence, lower OPEX and maintain pipe wall thickness. In summary, the internal and external coatings provide seamless, protected surfaces that will greatly strengthen the integrity of the pipeline for decades.

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**WE USE HIGH-TECH ROBOTICS TO APPLY CUSTOM ANTI-CORROSION COATINGS TO ID AND OD FIELD JOINTS.**

**Liquid Coating Ring**
Our Liquid Coating Ring automatically rotates around the field joint for a more consistent liquid epoxy coating application with no overspray.

**Internal Field Joint Coating**
We use specialized robotic technology to clean, coat and inspect internal field joints in new pipelines.

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**AEGION®**

Stronger. Safer. Infrastructure.™

Aegion Coating Services, The Bayou Companies, Brinderson, Corrpro, Fibrwrap Construction, Fyfe Co., Insituform, MTC, Schultz and United Pipeline Systems

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For a multitude of reasons, nuclear plants are required to prevent leaks and pipe degradation. While these buried piping systems can be difficult to inspect and rehabilitate, leaks from buried piping can result in releases of radiation, such as tritium, to the natural environment. Any public safety concerns could cause a plant to shut down. Therefore, supplying an adequate pressure barrier for piping systems is integral.

When a nuclear plant licensee attempts to meet U.S. Nuclear Regulatory Commission (NRC) requirements for renewing a plant’s operating license, the licensee must show it can account for the effects of aging on a plant’s systems, including long-lived buried piping structures important to safety. Some buried piping systems are part of larger systems required to be included in an asset management program, but these can be difficult to inspect and rehabilitate. The nuclear power industry is in need of safe, cost-effective, timely and low-risk pipe repair and replacement solutions to mitigate potential pipe leaks and structural issues.

Fibrwrap Construction and Fyfe Company were retained by a nuclear utility operator in late 2012 to provide turnkey services for a buried pipe replacement project. The purpose of this particular project was to supply a new pressure barrier for a piping system at a Southeastern nuclear power plant, which included almost 1,800 feet of 36-inch, 42-inch and 54-inch diameter carbon steel pipe which was prone to microbial influenced corrosion (MIC).

The issues with the piping system included leaking and loss of the minimum wall thickness required by ASME code. The proposed new carbon fiber-reinforced polymer (CFRP) pressure barrier repair system offered a solution that would provide structural integrity and watertight requirements. In addition to meeting these requirements, the epoxy systems used for the pipe replacement are not prone to attack.

The design and material qualification phase of the project went through late 2014, with the project implemented in 2015. The qualification process required the following testing and design activities:

- Comprehensive epoxy cure properties test (% cure vs temp vs time vs hardness)
- CFRP pipe compression test by parallel plate test method (ASTM D2412)
- Long-term durability testing (10,000 hr) at high temperatures and Arrhenius modeling
- Groundwater infiltration prevention test
- Non-destructive testing device to measure the minimum installed material thickness
- ASME B31.1 certified fully-structural pipe calculation

The project employed a first-of-its-kind, cost-effective repair and replacement approach consisting of in situ replacement of an entire piping system. CFRP was used to provide groundwater infiltration prevention as an alternative to costly and difficult welding repairs. In addition, new non-destructive test equipment was also developed to comply with nuclear QA requirements for during- and post-construction inspections.

**INSTALLATION**

The installation services included full time safety managers, quality assurance engineers, project managers, superintendents, crew leaders, hole attendants and laborers who performed a variety of activities.

The project specification required multiple hold points during the installation procedure including after surface preparation, priming, hole patch installation and fiber installation. It was the responsibility of the quality assurance engineers to officially sign off on each hold point along with the owner’s engineer during each inspection. In addition to the hold points, newly qualified non-destructive test equipment was developed to comply with the minimum installed material thickness requirement. The quality control inspectors provided a final quality control report with all the required documentation.
The project was completed from April 2015 to September 2015. Completion of the project resulted in the prevention of possible toxic material infiltrating into the groundwater and the prevention of loss of energy to affected communities. Additionally, the project saved the utility over a year of implementation and several million dollars in construction costs. The trenchless repair also represented a significant risk reduction for the utility.

The Tyfo® product installed was designed to provide both leak prevention and pipe strengthening. The goals of the owner were not only met, but surpassed in relation to cost savings, installation quality and mitigated risk. The Fibrwrap Construction installation team successfully complied with a nuclear safety culture and a nuclear quality control and assurance program to meet the client’s expectations and provide an improved piping system.

INSTALLATION ACTIVITIES

- PIPE CLEANING
- SURFACE PREPARATION
- PRIMING
- INSTALL DIELECTRIC BARRIER
- INSTALL GROUNDWATER INFILTRATION PATCH
- INSTALL FIBER AT BRANCH CONNECTIONS
- INSTALL LONGITUDINAL AND HOOP FIBER
- APPLY TOP COAT SYSTEM
In May 2015, Corrpro began working with CH2M Hill Alaska Inc. ("CH2M Hill") to provide a front end engineering design (FEED) project report for a pipeline project in Alaska. This particular project focused on a quality preliminary cathodic protection design and engineering plan for approximately 730 miles of natural gas pipeline.

The pipeline is part of the Alaska Stand Alone Pipeline, or ASAP. The purpose of the ASAP project is to develop a natural gas pipeline from the North Slope of Alaska to Southcentral Alaska. The final pipeline will be a 730-mile fusion bonded epoxy (FBE) coated pipeline.

According to the ASAP website, the benefits of the project include offering a “reliable, affordable energy source to the residents of Alaska” that could provide fixed energy costs to residents for the next 20 to 30 years through negotiated contracts. Some benefits of the development include a boost of 8,000 jobs to Alaskan residents during construction, increasing energy supply and boosting the state’s economic opportunities.

While Corrpro’s component was completed in 2015, it is just the beginning of a project that is estimated to be under construction until 2020.

**DESIGN**

CH2M Hill was selected by the pipeline owner, Alaska Gasline Development Corporation (AGDC), to provide integrated-team program management for the ASAP project. Ranked first in the world for program management of complex projects, and Alaska’s eighth largest employer, CH2M Hill will manage the project using its integrated-team program management platform. In addition, not only will the company help manage personnel and provide engineering services, they will also provide the systems, processes and tools necessary to support the project and oversee permitting, licensing, logistics, safety, quality, procurement and other services.

With construction expected to begin in mid 2016, AGDC expects the ASAP project to transport its first gas by late 2020. The development phase is expected to cost about $355 million, with actual construction estimates at $7.7 billion.

**FEED COMPONENT**

As stated earlier, Corrpro provided FEED project reports in preparation for the design and construction of the project. The FEED project report from Corrpro will be used to create a future materials and construction estimate for the project. To complete the project, Corrpro put together a diverse team of engineers and designers from its Seattle, Calgary and other North American offices, drawing on personnel with specific expertise in areas such as cathodic protection (CP) design in permafrost and arctic environments, AC interference and telluric currents to satisfy the advanced technical demands of this preliminary cathodic protection design. Telluric currents are electrical currents created by the interactions between the earth’s magnetic field and solar radiation. These telluric currents flow through the surface of the earth, through land and sea and can affect buried metallic structures like pipelines.

Corrpro’s project started with a detailed review of project documents provided by CH2M Hill. This included geotechnical reports on soil and geology in the proposed project area to determine soil pH, electrical resistivity and depth of permafrost — all highly important design considerations. Other information Corrpro used for analysis included GPS alignment data of the project pipeline, any foreign pipelines and AC transmission power lines and the overall design document. Measuring AC interference is important in determining the type of cathodic protection system that will mitigate AC interference. If it is not properly mitigated, AC interference can cause a pipeline to prematurely corrode and degrade.

CH2M Hill personnel worked closely with Corrpro’s design team throughout the project to identify and provide any necessary additional technical information. Corrpro focused its efforts on performing a detailed analysis of the project’s technical information to provide the best comprehensive CP design.
How does a cathodic protection system work on a coated pipeline?

A cathodic protection system can help provide corrosion protection to an FBE coated pipeline by providing a DC electric current to uncoated pipe sections. These uncoated areas are typically called “holidays” and may result from coating imperfections during coating application, coating damage during pipeline installation, coating damage caused by ground movement/disturbances or from coating failure from age. It is these holidays that are most susceptible to rust and corrosion.

LOCATION

The project pipeline alignment passes through both the Brooks and Alaska mountain ranges and three different ecological regions including the North Slope, Interior and Southcentral Alaska. While each ecological region has its own environmental factors that must be considered as part of the design process, permafrost and low temperatures must be considered throughout the alignment, or route of the pipeline. Furthermore, electrical power and communications will not be available for most of the alignment. Due to the size and location of this project, Corrpro’s cathodic protection design took into account numerous complex technical elements:

• Design and constructability limitations in frigid Arctic environments
• Electrical interference issues with overhead AC transmission power lines and the earth’s own magnetic field
• Providing reliable power generation in remote locations
• Cost-effective groundbed design
• Stress corrosion cracking
• Reliable monitoring design and equipment

Corrpro was chosen to provide a preliminary design that addresses the issues listed above and other technical considerations due to its proven expertise on projects of this size and complexity.

Corrpro’s design team developed preliminary cathodic protection elements such as anode groundbeds, power generation equipment and monitoring devices that take into account the pipeline’s coating, its Arctic environment and any possible AC/DC electrical interference issues. A final basis of design document is being prepared by Corrpro to provide a comprehensive review of the preliminary cathodic protection design and will include a narrative describing the cathodic protection design, detailed design drawings and bill of materials. These recommendations will help CH2M Hill to properly design and plan the type of cathodic protection system needed on the FBE coated pipeline to prevent rust and corrosion for years to come.
Aegion will soon introduce two small-diameter pressure pipe lining technologies. InsituMain®, a glass fiber-reinforced product in the portfolio for almost 20 years, is currently being modified to incorporate fabric and material refinements. The technical envelope of InsituMain® will expand to include pipes from 6- to 96-inch, and larger. Aegion’s newest development P3, or Premier Pressure Pipe, is a joint Insituform/Fyfe project using a carbon fiber-based pull-in lining system designed to address small-diameter pipes ranging from 6 to 12 inches.

Historically, success in lining small diameter water mains required not only a product that could provide pressure capability but also one with the ability to reinstate residential services from inside the liner pipe — eliminating the need to dig at every service connection. To address this, Insituform developed the iTAP® process of reinstalling connections used with the InsituMain® system. The iTAP® process is performed inside the lined pipe, eliminating the concerns relating to liner sealing around the service connections. However, since it is a proprietary system, it cannot be specified in most municipal contracts. Although many owners expressed interest, in the small-diameter water main lining arena, it proved difficult to be cost competitive using the iTAP® method.

NEW APPROACH

Thus, another approach was required. Over the past two years, there have been new developments in the Aegion product portfolio for pressure pipe lining. Insituform revisited the small-diameter lining concept with InsituMain® and elected to follow the current industry practice of simply drilling out the services. However, this approach required confirmation of sealing capability at ends and services. In a parallel endeavor, Fyfe and Insituform collaborated in the development of a small-diameter lining system, P3, comprised of carbon fiber, fiberglass and resin materials — the same as those used successfully for many years by Fyfe and Fibrwrap.

The success of both systems hinged on the ability to seal critical components with the liner/resin composite. The installation process for hand-layup CFRP (carbon fiber-reinforced polymer) provided valuable insights into the surface preparation required to ensure adequate bonding capability between the liner and host pipe. Current practice in small-diameter pressure pipe cleaning involves pigging, drag scraping, pressure flushing (from 2000 – 2800 psi), or a combination of these options. For the Fibrwrap® hand layup system, man entry allows very high pressure water cleaning (up to 30,000 psi capable equipment) on concrete pipe and metallic pipe, with sandblasting an option on metallic pipes. This provides a very clean surface with no corrosion, tuberculation or other undesired deposits remaining. Cleaning to that level is not possible in small-diameter pipes using current practices. In the case of some metallic pipes, intense cleaning also removes localized graphitized areas that can loosen over time and separate from the remaining solid material.

As P3 was being developed, the ability to seal at services and liner terminations was a primary consideration. One concept was to clean the pipe surface around the service using some form of rotating brush mounted on a robot. In initial tests on ductile iron pipe, service connections were tapped into the pipe, along with four small holes two inches from the service to assess leak tightness. The small holes were plugged with plastic bolts prior to lining. Surface preparation was then undertaken by robotic and hand brushing and grinding around services prior to lining. Each pipe segment containing a service was capped and pressure tested to 300 psi, with the majority showing no leakage at the observation holes or service.

Subsequent to the initial leak tightness test, Aegion identified a new process for cleaning small-diameter pressure pipes — Envirologics’ Tomahawk™ system. This system uses a vacuum to pull crushed granite of various sizes through the host pipe, removing all tuberculation and deposits and leaving a clean, dry surface. Around services, a combination camera/deflector is used to focus cleaning in areas where there are heavier deposits specific to water main lining. A vacuum truck capable of at least 3600 cfm is connected to one end of the host pipe and the feeder trailer top the other.
After observing Tomahawk™ in the field, Aegion contracted Envirologics to clean old, tuberculated cast iron pipe. Two hundred feet of a 6-inch cast iron pipe was obtained from a City of Calgary water main replacement program and shipped to Insituform’s Chesterfield, Missouri R&D facility. There the pipe was joined into 40-ft. long segments and tapped with simulated ¾-inch services. Observation holes were drilled along both the axis at 9 inches from the service and directly opposite the service.

Two of the cast iron pipe lengths were cleaned using Tomahawk™ in preparation for installation of the P3 liners. Sixteen test segments were removed from the pipe and subjected to hydrostatic pressure of 150 psi for the first hour and then at 300 psi the second hour. Fifteen of the samples showed no leakage at the observation holes or around the service. This result provides a high level of confidence in the capability of sealing at liner penetrations to allow internal reinstatement.

A sample of the Tomahawk™ cleaned pipe was assessed by Corrpro’s Chuck Moran, a NACE Level III Coatings Inspector. Because the pipe sample was severely pitted, some corrosion was left in the bottom of the pipe. (The estimated level of cleaning was equal to a SSPC-SP6/NACE #3 Commercial Blast Cleaned Surface.)

The Tomahawk™ system provides a cleaned surface exhibiting features that lend themselves to improved bonding capability between the liner resin and the host pipe. The surface is not smooth and has "hills and valleys" that increase the surface area of the host pipe interior for contact, as well as provide an opportunity for mechanical lock.

The results of this investigation indicate that aggressive surface preparation prior to installing a cured-in-place pipe pressure liner offers an excellent condition to seal around service connection prevalent in small-diameter water mains. However, this assumes that the resin possesses the qualities needed to achieve a reasonable bond. Demonstration testing should be implemented to confirm the results.
The increase in oil and gas production rates over the past two decades in Arabian Gulf countries has led to the development of new fields and the expansion of existing fields, requiring new wells to be drilled in close proximity to existing wells. Most Middle East oil companies provide cathodic protection (CP) of onshore well casings. In cases where wells are installed relatively close to each other or are connected to a common flowline network, a single cathodic protection system can be used for multiple well casings.

The cathodic protection current requirement for well casings are typically predetermined from historical records and downhole logging techniques. Many companies do not allow insulating joints between the well casing and flowlines or the use of variable resistors. These restrictions make it difficult to control the CP current to individual well casings. The best approach is to vary the electrical resistance of the CP circuits. Increasing the circuit resistance to a well will decrease the corresponding cathodic protection current.

**PROGRAM IMPROVEMENTS**

Corrpower’s engineers in Saudi Arabia have developed a software program to assist in the design of cathodic protection systems for multiple well casings. The program simulates a cathodic protection circuit where the power supply and EMF voltages are represented by a DC battery symbol. Individual resistor symbols are shown for:

- Well to earth resistance
- Flow/trunk line lineal resistance
- Flow/trunk line to remote earth resistance
- Negative cable resistance of each well

The primary variable in controlling the CP current to individual well casings design is the resistance of the negative return circuit. Varying the length and size of negative cable and the location of the cable connection to the flowline impacts the CP current to the corresponding well casing.

With the EMF voltages and resistances entered into the simulation program, virtual ammeters show the CP current drain to each well casing. Changing the rectifier voltages and cable resistance varies the current drain to the well casing. Cable sizes and lengths can then be incorporated into the cathodic protection design to match the resistance values of the simulation program.

The following schematic demonstrates the simulation program of a cathodic protection system for three separate well casings. In this case, the rectifier requires a DC output of 14.8 volt and 45.4 amps.
The simulations above indicate the negative cables scheme and current drain to associated structures shown in the table below.

### SIMULATED CHARACTERISTICS OF NEGATIVE CABLES

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<th>STRUCTURE</th>
<th>CURRENT DRAIN</th>
<th>SIZE (SQ. MM)</th>
<th>LENGTH (M)</th>
<th>RESISTANCE (Ω)</th>
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