

CORROSION



ICCP Offshore Wind

Impressed Current Cathodic Protection



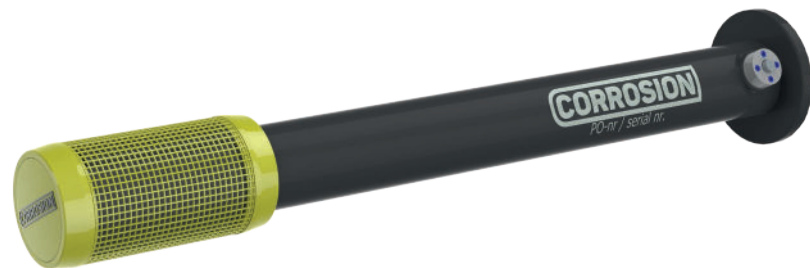
ICCP Offshore Wind

Let's make wind **truly** sustainable

Modern day wind turbines are often located in or near (sea) water. This means they too are susceptible to corrosion. CORROSION is at the forefront of innovation in the wind sector and is the worldwide market leader in protecting wind turbine foundations against corrosion in an environmentally friendly way by using Impressed Current Cathodic Protection (ICCP).

With our Dutch roots in the use and development of wind turbines, we as CORROSION are proud to contribute to this industry. We were the first to see the possibilities and we continue to bring successful sustainable solutions to this industry.

In today's environmentally conscious world, industry classification societies establish and maintain a growing set of standards regarding the protection of submerged and buried parts of wind turbine foundations against corrosion. Cathodic Protection (CP) systems are one example of these mandatory systems.



CP is a technique used to control the corrosion of a metal surface by making it the cathode of an electrochemical cell. This can be achieved in different ways. One way is to use a passive Galvanic Anode Cathodic Protection (GACP) installation system which uses aluminium anodes. However, this system is a major source of pollution due to the extreme amounts of anode material it deposits into the water as the anodes dissolve.

A more eco-friendly manner is to use an almost inert mixed-metal oxide coated titanium anodes in an active electrical controllable system called an Impressed Current Cathodic Protection (ICCP) system. Because the world is becoming increasingly aware of environmental factors, some countries now prohibit the use of GACP installations as the CP for metal constructions in open waters. Then, an ICCP system is the only solution to protect the assets. What's more, ICCP is less expensive in both OPEX and APEX.

CORROSION is the global leader and specialist in designing, manufacturing, maintaining, and operating ICCP-systems. Our systems are innovative and compliant to legislative regulations. And they achieve the highest levels of efficiency and protection.

ICCP system

CORROSION's highly sophisticated Impressed Current Cathodic Protection (ICCP) offshore wind system is the most cost-effective, easy-to-maintain and environmentally friendly solution on the market for the protection of offshore wind turbine foundations against corrosion.

The ICCP-system consists of:

- Anodes made of an inert mixed metal oxide (MMO) anode material
- Sensors that continuously measure the protection rate of the foundation construction
- Cabling, specially designed and tailor-made to meet the challenges of the harsh offshore environment
- Optimum CP design
- High frequency power control unit that provides the required protective currents calculated by a software control program specifically designed for ICCP systems
- SCADA system for remote monitoring and control from any location, such as a substation, an onshore control centre, or directly from our offices

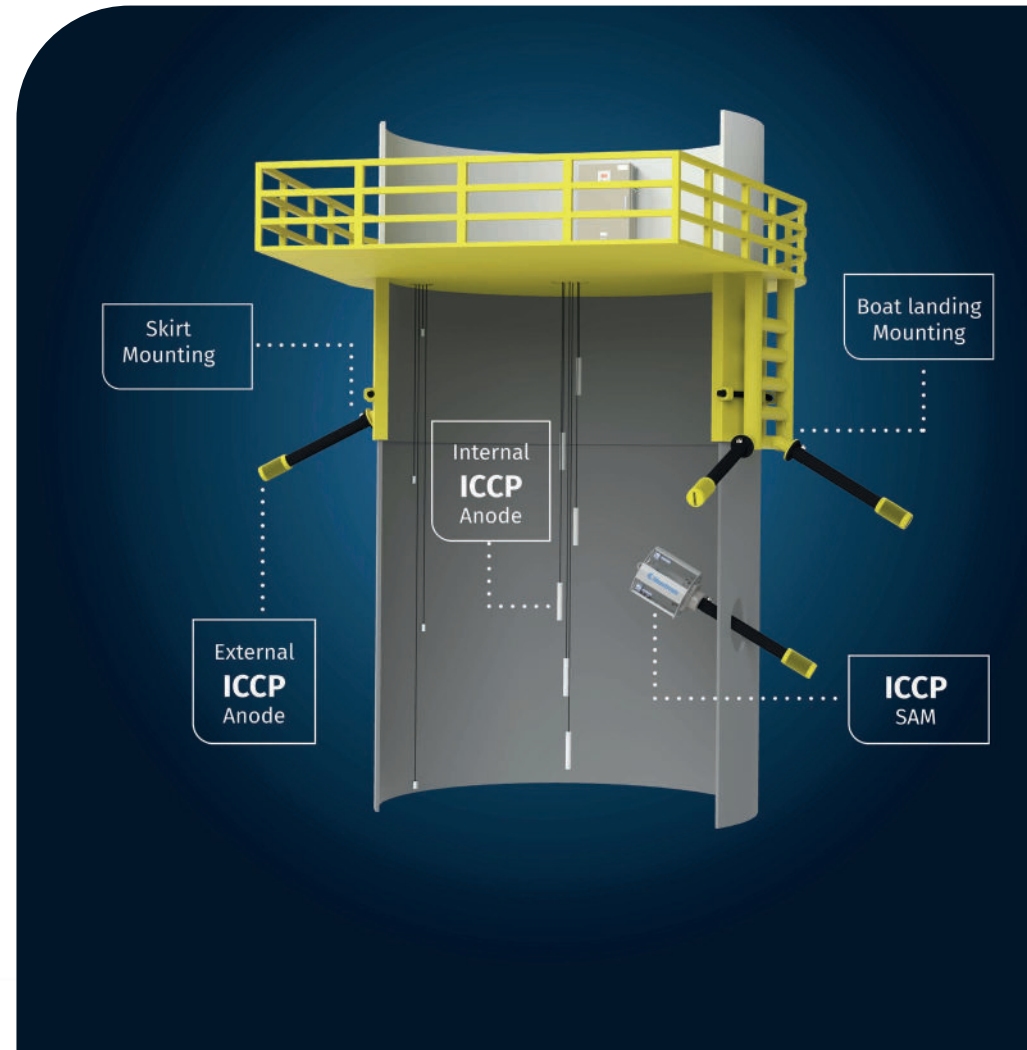
External Protection

With our latest external ICCP anode design, we respond to the developments in the market of offshore wind turbine corrosion protection, the increasingly challenging weather conditions, and the need to protect increasingly larger foundations, also known as the XX(X)L monopiles, in an environmentally friendly way.

The ICCP anode is proving highly effective on offshore turbine foundations worldwide. CORROSION's 'slim fit' anode design delivers the same quality and reliability as an original ICCP system, but is more efficient, versatile, and future proof.

This ICCP anode design represents a huge step forward in efficiency in wind turbine corrosion protection. The anode head is more powerful and can therefore 'impress' more current. This makes it possible to protect the largest monopiles and reduce the amount of coating on monopiles to no coating at all.

In addition, this design offers a unique and new installation option. Besides to mounting on a TP and boat landing ladder, this anode can also be installed on the foundation itself. Which leads to big savings in time and money in wind turbine protection



Internal Protection

ICCP systems have become the standard solution for internal protection against corrosion in monopile foundations. Only a few ICCP anodes are needed to provide optimum protection. Several low weight ICCP anodes hang down from the airtight platform in the monopile and provide optimum cathodic protection. The control of the internal protection requires precise and ongoing attention due to the confined space and special environmental conditions. CORROSION has developed a unique Reduced Hydrogen Development Software program (RHDS) specifically for the internal protection of monopiles.



Sustainability

Few people realize that many wind farms are far more eco-friendly above water than below it. Like any metal structures in marine environments, wind turbine foundations are susceptible to corrosion. Unfortunately, traditional methods of protecting against this are by no means pollution free and sustainable.

The use of sacrificial anodes leads to the release of heavy metals and metals such as zinc and aluminum into the marine environment. The result? Over the 25-year lifetime of a wind farm, literally millions of kilograms of metal alloys can be discharged into the seawater. What's more, the sourcing, transportation and maintenance of the metals used in sacrificial anodes, also comes with a significant carbon footprint.

Thankfully this is not a problem without a solution. Impressed Current Cathodic Protection (ICCP) systems provide superior protection to traditional systems, but without the negative effects on the environment. We hope more and more companies in the wind sector will continue to embrace ICCP technologies. Together we can make wind turbines as clean and sustainable as the energy they produce.

Our partners

We believe that by combining forces and expertise we can offer (turnkey) solutions to serve our customers even better. Together we provide sustainable cathodic protection solutions for offshore wind farms. From design and manufacturing, to commissioning and maintenance.



Amphibious Energy is a specialist in designing offshore, autonomous and 100% renewable energy power generators, the company combines wind and solar power with storage, in a compact and transportable design. These first-of-its-kind electrical power generators – EnergyPods – are a sustainable, zero-emission alternative to diesel gensets, and offer affordable, reliable and clean energy. Amphibious Energy is actively involved in Central North Sea projects to support operators in becoming net-zero in their operations.



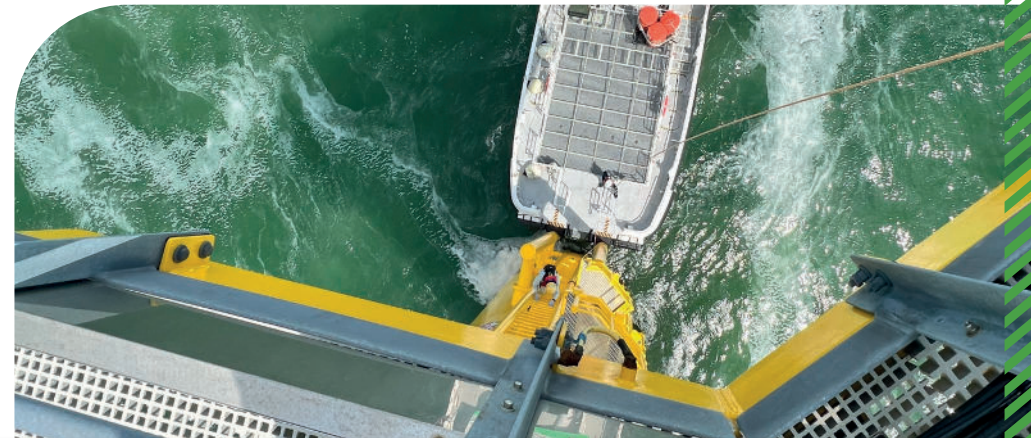
Bluestream is a leading offshore contractor, providing specialist technical services above and below the waterline. They are highly skilled in surface supplied diving, Remotely Operated Vehicles (ROVs), working at height, rope access and Unmanned Aerial Vehicles (UAV). They provide their clients with tailored solutions to ensure sustainability and profitability during the installation, maintenance and decommissioning of their offshore assets. To do this, they combine profound knowledge and decades of experience with the ambition to innovate in a world where the energy industry is evolving.



Elsyca is active in the markets of corrosion design & engineering, cathodic protection & AC mitigation, surface finishing, and electrochemical manufacturing. Within a variety of industries – such as oil & gas, automotive, aerospace & defense, electronics and medical. The combination of the practical engineering knowledge, the in-house developed family of engineering simulation tools, and the continuous focus on R&D and innovation has established Elsyca as a trustworthy and appreciated partner for many clients across the globe.

ProCon

ProCon is an international ISO9001, ISO14001, ISO45001 and UN SDG certified company that offers specialized and high-quality solutions to the global offshore and onshore wind industry as well as the solar power industry. ProCon provides full electrical EPCI and service of projects regarding transition pieces, jackets, e-modules, wind turbine generators, balance of plants, substations and solar farms – including the medium and high voltage work.



ICCP-SAM

In association with Bluestream

The ICCP-SAM is specifically designed to remotely install ICCP anodes on monopile foundations of all sizes, anywhere on the foundation and even in the roughest ocean conditions.

The ICCP-SAM (Subsea Assembly Method) is extremely compact and can be transported and deployed with minimal resources from the topside of the offshore foundation. The ICCP-SAM is operated remotely and maneuvers the anode underwater into the designated foundation entry hole. The anode is then secured to the foundation using the same tool. One of the biggest benefits is that an anode can be replaced in the same way throughout the lifetime of the foundation. Even more important, it eliminates the need for diving operations.



In addition to its infinite applicability to protect monopile foundations of all sizes worldwide, this method of installation leads to major savings in time and money. Unlike traditional methods which require larger installation vessels and a significant amount of secondary steel or a vulnerable CPS construction, this new installation method comes only with a few design requirements and does not require large supply vessels. Another major advantage is that every type of monopile can now be protected in an environmentally friendly way during its entire lifespan. From the moment of installation to decommissioning.

ICCP-POD

In association with Amphibious Energy

The ICCP-POD is an environmentally friendly alternative to using diesel generators to supply energy during the construction phase of wind turbines, and sacrificial anodes to protect turbine foundations against corrosion.

The ICCP-POD combines two advanced technologies. The EnergyPod developed by Amphibious Energy, is an easy-to-transport autonomous energy plant that uses sun, wind, batteries and intelligent electronics to provide sustainable energy during the 18-month construction of wind turbines, meaning that costly and environmentally unfriendly diesel generators are no longer required.



To protect against corrosion during this construction phase, CORROSION developed compact ICCP (Impressed Current Cathodic Protection) units. By using an electronic current supplied by the EnergyPod, these represent an innovative eco-friendly alternative to sacrificial anodes, which discharge large quantities of metals and heavy metals into the water. When the wind turbines are installed and grid-connected, the energy supply for the ICCP system is switched from the EnergyPod to the wind turbine itself.

ICCP Maintenance

Onshore Inspection

CORROSION's ICCP systems are often installed by the yard or another third party. Onshore inspections are therefore essential to ensure correct installation before the equipment is installed offshore and is no longer accessible or difficult to access afterwards. By having a trained CORROSION Engineer carry out the inspection, the customer can be sure that the installation has been done correctly and that it is under guaranteed performance.

Offshore commissioning

To ensure proper operation and calibration of the installed ICCP components, the final commissioning will be carried out Offshore. Our technicians are highly trained and always in possession of the necessary certificates and diplomas.

O&M Services

CORROSION can provide a service engineer to join the customer's O&M team to support and instruct the technicians for future reference. If necessary, our engineers can also visit a wind farm to carry out maintenance.



SCADA Remote Monitoring

CORROSION ICCP systems have been designed to be SMART. The corrosion protection performance of each wind turbine can be tracked from wherever you are, while data readings and adjustments can be achieved at the click of a mouse.

SCADA systems are able to monitor and provide remote control of wind farms spread over a large geographical area for which organizations do not have sufficient personnel to cover. Reliable communication and operability of these areas or sites is critical to operational reliability.

SCADA is an essential part of ICCP systems for Offshore projects and is specifically designed and set up according to your project's individual design specifications.



Laboratory

CORROSION is unique in many ways. One of the things that makes us different is our on-site research laboratory. This is the place where we build on our many years of experience and expertise.

And while we have a sound reputation and proven products, we want to continue bringing you new developments. CORROSION strives to pioneer in ways that go beyond theory and ideas. Our lab is an ideal place to continue our mission to bring you the most sophisticated, high-quality products and services available in cathodic protection and anti-fouling technologies. It adds specialized services to our already strong reputation for product reliability and performance. And because the environment is an ever-growing concern, our lab also allows us to look into more sustainable solutions and improvements. The best products, with an eye on our surroundings whenever it's possible.



Applied Science

Our laboratory is an arena for applied science. We strive to be the bridge between academic knowledge and practical application. Science for the real world. So, we work with partners who are widely recognized, and like us, specialists in materials and corrosion solutions in a wide variety of environments. This collaboration comes together in our on-site lab, like a melting pot where our expertise is mixed with new ideas. Our findings are then applied to the problems our clients face every day in many different industries.

In addition to these cooperative efforts and our on-site practical facilities, our lab also has access to a large database of scientific publications and reports. This means our clients will always benefit from the latest developments in materials, technology, and scientific knowledge in the field of corrosion and anti-fouling.



About CORROSION

CORROSION has been in the business of protecting offshore wind farms, vessels and onshore applications since 1993. From our humble beginnings in the small town of Moerkapelle in the Netherlands, we've grown into an internationally recognized leader in creative, sustainable, state-of-the-art solutions in corrosion and cathodic protection.

Our highly sophisticated ICCP and ICAF systems are utilized by companies large and small around the world, protecting their valuable assets and equipment in even the toughest and most demanding conditions. We're proud of the quality of the products we offer and the level of service we provide. Excellence is born of experience and expertise, and our unique research laboratory at our global headquarters in Moerkapelle is the beating heart of our company. It's where we test and develop new products and services, enabling us to lead the way in creating innovative anti-fouling and corrosion solutions.

Over the last three decades, we've expanded not just in terms of what we do, becoming a major global player in anti-fouling and maritime protection, but also geographically, with successful subsidiaries everywhere from Germany and France, to China and Vietnam.



ISO

Our customers and relations must be able to trust that our products and services meet the highest quality and safety standards. To guarantee this, we have annual independent audits carried out to comply with the conditions and rules of the International Organization for Standardization (ISO) the safety of our people. All things we at CORROSION take very seriously.

ESG

We believe that all organizations have a social responsibility. Such as reducing the impact on the environment, contributing to the community in which you operate and the safety of your employees. These are all matters that we take very seriously at CORROSION. The way we try to achieve this is based on international ESG criteria.

ESG stands for Environment, Social and Governance. Finding a balance between financial and economic results, transparency, social interests, and the environment. And the challenge of maintaining that balance. Within CORROSION we have set various objectives, both for the short and the long term.

Offshore Wind projects

- Greater Gabbard
- Riffgat
- Dan Tysk
- Luchterduinen
- Butendiek
- Zhongmin I & II
- Albatros
- Alpha ventus
- Hohe See
- Horns Rev III
- Merkur
- Borkum West II
- Meerwind
- Sandbank
- VejaMate
- Galloper
- Belwind
- Yunlin
- Triton Knoll
- Akita Port
- Borssele III, IV & V
- Noshiro Port
- Mermaid
- Seastar
- Rentel
- Arkona Becken
- Northwester II
- St. Nazaire
- Deutsche Bucht
- Kaskasi
- Three Gorges
- Changle A & C
- Three Gorges H6 + H10
- Dafeng Longyuan
- Baltic Eagle
- Hollandse Kust Zuid
- Hollandse Kust Noord
- Walney
- Sofia
- China Energy Peninsula 4
- Jiangsu Longyuan OWF H4 H

Floating

- Golf Du Lion

Substations

- Dan Tysk
- Dan Tysk OAP
- Meerwind
- Borkum West II
- Global Tech
- Xinghua Bay
- Northwester II
- Dolwin Gamma
- Baltic II
- Riffgat
- Changle A
- Kaskasi

**Protecting foundations
against corrosion
since 2007**

+3100

+4576

+5690

+2500

**ICCP Systems
External anodes
Internal anodes
Foundations**

Contact us

We hope that this brochure has been of interest to you. We would be happy to answer any questions you may have or work with you to see whether ICCP meets your specific needs.

For further information, other brochures and whitepapers, please visit our website corrosion.nl. You can also reach us by e-mail at info@corrosion.nl or telephone at: +31 (0) 79 593 1295.



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