NeSSIE
North Sea Solutions for Innovation in Corrosion for Energy
Co-funded by the European Maritime and Fisheries Fund

02

# Technical Challenges

Surveys and interviews for the NeSSIE project have identified the following key challenges encountered with anti-corrosion solutions (ACSs). Although this is not an exhaustive list, project proposals are expected to come from these areas.

| Key Challenges | Examples |
|---|---|
| **Cathodic protection** | Hydrogen embrittlement, cathodic disbondment |
| **Preparation and applying coatings** | Preparation of surface to get required roughness bring difficulties: not all areas can be blasted, thicker paint layer more susceptible to cracking (*welds/corners*) |
| **Maintenance difficulties and repairs** | Locations that are more susceptible to damage (*boat landing, flanges, edges and corners*), weather windows, application conditions (*wet surfaces, temperatures too low*) |
| **Inspection** | Costly, undiscovered damage |
| **Experience and unknowns** | Regulation, knowledge transfer between sectors, corrosion below the mudline after installation |
| **Novel product risk** | Consolidation of the market, variance in test data/reliability tests |
| **Design** | Unable to protect/coat certain designs, material selection, use of high strength construction steels |
| **Quality control** | Unrealistic demands, inspection criteria and procedure not well defined |

**It is important to note that the examples and explanations give an indication of the identified challenges within the NeSSIE project. The challenges are not limited to the description provided. More detail is contained in the challenge sheets below.**

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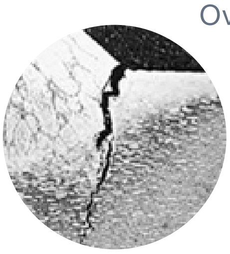
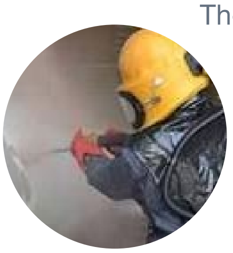
## CHALLENGE 1
### Cathodic Protection



Over-protection can be an issue with CP, this occurs when the anode generates more current than necessary to protect the metal from corrosion and result in different problems such as hydrogen embrittlement and cathodic disbondment. Hydrogen embrittlement can occur when hydrogen is built up, leading to unexpected fracture of the metal. Cathodic disbondment is another result of over-protection, where the adhesion between the anticorrosion coating and the protected structure is lost.

Figure source: TWI Global

## CHALLENGE 2
### Preparation and applying coatings



The preparation and application of coatings are extensive procedures and this complexity comes with various challenges. The surface of a structure needs to be of a certain roughness to ensure adequate adhesion of the coating. However, different types of steel in the same structure need different types of blasting preparations, which increases the complexity of the process and therefore the chances of defects. Typical coating systems consist of three paint layers, leading to high labour costs. Specific locations, such as welds, corners and edges, need to be manually applied with a brush to ensure coverage, yet this can lead to a too high thickness layer, resulting in the necessity of reworking. The coating system thickness should not be too high to avoid cracking or delamination (for example with zinc rich coatings). Another problem with the application of paints occurs with solvent free paints, as they are often more difficult to apply due to a higher viscosity. For example, the spray application system for these paints can become quite heavy, bringing difficulties for the applier.

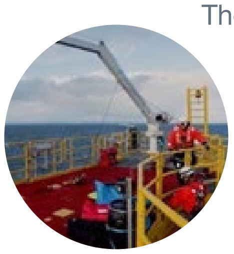
Figure source: ACT

## CHALLENGE 3
### Maintenance difficulties and repairs

In general, the high cost of maintenance in offshore facilities is a key challenge to the sector. Maintenance regarding corrosion prevention is often related to damage of anti-corrosion coatings. This damage can occur during use of the device, when vibrations and forces cause slight displacements. For offshore wind, this damage to coatings is often found between the flanges, resulting in corrosion.
In addition, in the case of offshore wind maintenance vessels need to land on the (secondary) structure. The friction that occurs with this boat landing damages the coatings, requiring repairing of the coating. Repairing the coatings offshore, is a labour and time intensive, and therefore costly activity. Due to the offshore conditions, the need for the right weather conditions can prolong the process. If, due to weather conditions, there is too much time between coatings, cleaning of the surface to clear salt deposits needs to be repeated.

Figure source: Incon

## CHALLENGE 4
### Inspection



The inspection of the installed devices is a costly activity. High costs are related to the deployment of maritime vessels, with high dependence on weather windows and availability of the inspection vessels.

There have been instances where corrosion damage has gone unnoticed. An example of unnoticed damage occurred with polyurea coatings, which have high strength and flexibility characteristics. Corrosion of the metal structure had occurred beneath the coating, leaving a shell of coating without any structural strength.

Figure source: SMC

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## CHALLENGE 5
### Experience and unknowns

Due to the relative lack of knowledge in certain areas of the ORE sector, some R&D areas need further investigation to establish the impact of corrosion. An example is the rate of corrosion below the mud line, about which very little is known.

The assumption is made that microbiologically induced corrosion (MIC) occurs in the first meter below the seabed, and that no corrosion occurs further down than 1m. Research towards MIC is another topic of interest.

Another topic that requires further research is the effect of pile driving, on fixed offshore wind structures, and specifically on the coatings. An example considering wave and tidal devices, little is known on the long-term effects of harvesting these energies on or close to the splash zone. In addition, the relatively little expertise of the regulatory sector in ACS is perceived as a key challenge.

## CHALLENGE 6
### Novel product risk

The development of new products comes with uncertainties and therefore risks. Test-plates, so-called coupons, installed on marine devices to measure corrosion do not properly represent the structure itself.

The coupons are not always electrically connected, or with the same potential, and have different spatial properties to the structure such as thickness, ratio of thickness over area, edges and shape.

These coupons are more susceptible to corrosion than existing offshore structures due to the potential of cracking or delamination of anti-corrosion coating at these locations. In addition, coupons located at different locations within a single wind farm display large variations in corrosion. This proves difficult for the track record of a solution. The lack of track record and name recognition of novel solutions is perceived as risky, as cost of failure is high.

Additionally, consolidation of the mature market is perceived as a main risk for novel products. Customers rarely are willing to pay premium price for custom-engineered product, as they are competing with low-cost solutions.

Thus, can reduce the potential of a new product to roll-out, for example for a new paint or novel material.

Figure source: G2MT Laboratories

## CHALLENGE 7
### Design

The design of a device should consider the corrosion protection method in the early design stages, whether by investigating non-corrosive materials (such as composites) or considering the requirements for ACS applications (for example with coatings).

In the case of coatings, the structure needs to fulfil certain requirements to be able to be painted, for example the paint cannot be applied in all angles or holes due to the inability of the paint systems to be put in certain positions.

Other issues with design have occurred with material selection, for example in the case of bolts. If the bolts are made of a less noble metal than the structure, the contact between these metals can result in galvanic corrosion, where the bolts act as the anode and corrode more rapidly.

In addition, in some cases the need for maintenance and inspection has not been considered at the design stage, complicating the execution and increasing the related costs, for example for difficult to access areas.

Figure source: iStock

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## CHALLENGE 8

### Quality control


Certification is required to ensure the quality of a product or service. Therefore, it is of importance to ACS as bad workmanship can significantly affect the performance of the ACS and drive up cost. A lack of quality control during fabrication has been a source of corrosion, leading to significant costs during project execution and operation. Additionally, the control process is perceived to have a “spot check” approach rather than a holistic system check, providing a barrier to the introduction of single layer coating systems. However, the certification process of ACS, comes with difficulties such as unrealistic demands of the standards demands of the standards, specifically for the coating process. Another example of standards being misrepresented can be found with the preparation process for coatings. Certain materials, such as stainless steel, cannot be blasted with the same iron grit as the rest of the structure. However, practice has shown that, in certain cases, blasting stainless steel with iron grit followed by adequate coating gave very good results. However, as this is a deviation from the standards, it is not allowed. Such examples of deviations from standards resulting in important cost reductions, without apparent loss of performance should be further validated and after a positive evaluation be taken up in standards.

In some cases, standards are inexplicit. An example is the specification of weld seams to be “smooth”, however a clear measurable definition of smooth is absent. Another example is the requirement of reworking small defects to comply with the requirement for ‘no paint defects’, which can result in a high cost and a lower effectiveness of the coating.