Life extension and CP retrofit

Thousands of permanent offshore structures for oil and gas production in the world, like steel jacket platforms, subsea pipelines, floating production and storage facilities (FPSO) are reaching or have exceeded their original design life. They require extension of life or requalification programs to prolong their operating life.

Cathodic protection (CP) is one of the issues to be managed as part of the life extension projects of existing structures. In case the original CP system cannot guarantee the planned residual life, a retrofit intervention shall be designed and executed.

CP retrofit is also a need for Offshore Wind Farm structures, such as monopiles and jackets.

The design of CP retrofit systems does not follow the criteria and approaches adopted for new facilities, as the intervention shall be executed with the structure in-place, and this has a strong impact on installation works. Accordingly, dedicated CP expertise has been developed for CP retrofit, aimed to select the most convenient system between impressed current and galvanic anodes. Actually, even if general rules exist, for CP retrofit projects, it is recommended to perform a dedicated technical and economic assessment study.
**CP retrofit of shallow water platforms**

Small size steel platforms in shallow water can be retrofitted using either galvanic anode or impressed current systems. Anode pods (Fig. 1) laid on sea floor and electrically connected to the jacket represent a quite competitive and cost effective option. If needed, it can be integrated with galvanic anodes directly clamped on structural elements. Impressed current systems can also be adopted based on the remote anodes concept. Both anode strings laid on sea floor or anode sleds can be used. Remote anodes can be integrated with impressed current anodes pile mounted type (Fig. 2).

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<tr>
<td>IMPRESSED CURRENT</td>
<td>FEW ANODES REQUIRED WITH HIGH CURRENT OUTPUT</td>
<td>ELECTRICAL POWER AVAILABILITY NEEDED</td>
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<td>CURRENT OUTPUT EASILY ADJUSTABLE</td>
<td>MAINTENANCE AND INSPECTION OF FEEDING SYSTEM REQUIRED</td>
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<td>QUICK INSTALLATION</td>
<td>POSSIBLE MECHANICAL DAMAGES TO ANODES AND CABLES</td>
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<td>SACRIFICIAL ANODES</td>
<td>NO MAINTENANCE REQUIRED</td>
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<td>NO OVERPROTECTION</td>
<td>HIGH INSTALLATION COSTS, IN PARTICULAR IN DEEP WATERS</td>
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![Fig. 1 - Anode pods with aluminium alloy – 300 kg anodes](image1)

![Fig. 2 - Pile mounted anode with Ti-MMO rod](image2)

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**CP retrofit of subsea pipelines and other**

![Galvanic anode sleds (retrofit of subsea pipelines)](image3)

![Segment of clamp with galvanic anodes (monopiles, single point moorings, etc)](image4)
One of the most versatile and effective solutions for deep water platforms retrofit is represented by the so-called Tensioned String of Anodes – TSA1 system. The TSA system consists of mixed metal oxide activated titanium LIDA anodes assembled on a mechanical supporting rope. The TSA is tensioned between anchor points on the sea floor (clamps or dead weights) and on the lower deck of the platform, and can be installed inside or outside the jacket.

The system provides significant advantages in terms of easy distribution of the impressed current anodes based on the local current demand. The design of the system shall be accomplished by using modelling of the current and potential distribution using computer modelling. For such applications, CESCOR developed specific capabilities using finite elements or boundary elements methods to optimize positioning of the TSA.

The Tensioned String of Anodes and the relevant mechanical connections (pad-eye, spring tensioner, turnbuckle, and adjustment chain) are verified with respect to wind, waves, and marine current solicitations by performing a structural analysis based on the actual TSA characteristics and on the 100-year return period extreme environmental conditions.

1 TSA and LIDA are trademarks of Industrie De Nora SpA.
Retrofit projects include installation of permanent reference electrodes, distributed in critical positions convenient to detect under-protection as well as over-protection conditions. Modelling is used to optimize the number of permanent reference electrodes and to interpret potential readings. High purity zinc is the preferred reference electrode type. Zinc electrodes are available in different shapes and assembly configurations (Fig. 3, 4).

**Cescor Services**

For CP retrofit, CESCOR provides:

- CP retrofit design
- Material supply
- Monitoring systems design and supply
- Supervision to commissioning and installation works

**Selected papers**