Impressed Current Cathodic Protection Retrofit System
Icorr Aberdeen

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Impressed Current Cathodic Protection Retrofit System
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Agenda
1. TAQA
2. Sacrificial Anodes Vs Impressed Current
3. History – North Cormorant
4. CP Inspection History – North Cormorant
5. Facts – North Cormorant
6. CP Assessments
7. ICCP Project Scope and Requirements
8. Commissioning
9. Results
10. Conclusions
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1. TAQA

Northern North Sea (2008)
- Cormorant Alpha
- North Cormorant
- Tern
- Eider

Central North Sea (2013)
- Harding
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2. Sacrificial Anodes Vs Impressed Current

From BS CP1021:1973
### Sacrificial Anodes versus Impressed current

<table>
<thead>
<tr>
<th>Sacrificial Anodes</th>
<th>Impressed Current</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) Independent of any source of electrical power</td>
<td>1) Requires a mains supply or other source of electric power</td>
</tr>
<tr>
<td>2) They may be required at a large number of positions. Their life varies with</td>
<td>2) Requires generally a small total number of anodes</td>
</tr>
<tr>
<td>conditions so that replacements may be required at different intervals of time and</td>
<td></td>
</tr>
<tr>
<td>different parts of the system</td>
<td></td>
</tr>
<tr>
<td>3) Their output cannot be controlled but there is a tendency for their current to</td>
<td>3) Requires relatively simple controls and can be made automatic to maintain</td>
</tr>
<tr>
<td>be self-adjusting</td>
<td>potentials within close limits despite wide variations of conditions</td>
</tr>
<tr>
<td>4) They cannot be misconnected so that polarity is reversed</td>
<td>4) Requires the polarity to be checked during commissioning because misconnection,</td>
</tr>
</tbody>
</table>
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3. History – North Cormorant

- North Cormorant was constructed in the late 1970s
- Installed in 1980/81
- Eight-legged steel piled jacked
- No coatings applied other than the risers
- No corrosion allowance was considered for structural steels
- Original designed by using sacrificial aluminium alloy galvanic anodes
- The asset remains viable and serves as a critical hub for major fields in the area
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5. CP Inspection History – North Cormorant

Graph 1 indicates pipeline potentials from 2002 to 2007. The potentials show a gradual decline during this period at the North Cormorant end – KP 16.54.
5. CP Inspection

Figure 1: Anode depletion in 2007
5. CP Inspection History – North Cormorant

**Summary of Elevations**

- **Average Potential (mV vs Ag/AgCl)**
- **Year**
- **ELV -18m**
- **ELV -46m**
- **ELV -74m**
- **ELV -102m**
- **ELV -130m**
- **ELV -158m**

30/01/2018
5. CP Inspection History – North Cormorant
5. CP Inspection History – North Cormorant

**ROV SURVEY RESULTS – 18/06/2014**

- Integrity threat
- Corrosion TA & Structural TA
- Action was taken to re-instate the CP System
5. CP Inspection History – North Cormorant

Figure 4: Example of Depleted Anode at EL158
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4. Facts – North Cormorant

- Submerged jacket structure is 3x height of St Nicholas House,
- Structural members made of offshore submerged arc welded structural steel grade – BS7191
- Fabricated from 5 km of tube diameter 0.7m to 6m and wall thickness between 20mm to 65 mm,
- Any attempt to justify a corroding jacket would require extensive subsea inspection,
  - Widespread removal of marine growth before CVI and NDT inspection,
  - Annual cost for inspecting 1% of the welds (30welds) £3.75m; 10% of welds (300 welds) £37.5m,
- Corrosion was extremely difficult to predict and could be influenced by galvanic corrosion, MIC, pitting and PWC
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6. CP Assessments

- Assessment,

✓ Massive daunting task to calculate the surface area from pre-electronic drawing era and old scanned documents; it was calculated to be in the region of between 75,000 and 85,000 m².

✓ There is currently no guide or standard for offshore retrofit CP designs,

✓ Previous studies and structure current average were used to calculate current requirements,

✓ A galvanic anode system would have required over 600 gross tonnes of anodes to the structure,

Challenges being:

- How much contingency does one add in to account for re-polarization of the existing system?
- How long will take the system to re-polarised?
- When will retro-fit system get installed and commissioned?
- Financial constraints
- Safety
6. CP Assessments

- After 33 years length a new protection system was required – studies conducted between 2011 and 2014 concluded that retrofit sacrificial anodes would not provide the required repolarization current and their **size was impractical**; so installation of an **impressed current system was required**.

- Assuming 80,000 m² surface area,
- @ 4200 A equated “mean” current density of 52.5 mA/ m²
- Capacity available for redundancy and “final” current
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7. ICCP Project Scope and Requirements

- Purchase eight transformer rectifier units (TRU) and subsea anode retro-buoys
- Purchase new subsea cables; one for each retro-buoy
- Attach the subsea cable to the ICCP retro-buoys, install on seabed, including stabilisation and protection as may be required,
- Hook-up subsea cables to the TRU and TRU to North Cormorant power supply
- Commission system
7. ICCP Project scope and Requirements
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8. Commissioning

The retrofit Impressed Current CP (ICCP) solution for TAQA’s North Cormorant Platform was commissioned in January 2016 and consists of 8 complete systems each with the following components:

- 8-off seabed mounted impressed current Retrobuoy anode skids
- 8-off subsea anode power cables
- 8-off transformer rectifier (DC power supply)
- CP monitoring systems.
8. Commissioning

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9. Results

![Graph showing potential (mV wrt Ag/AgCl) vs depth (m). The graph includes lines for As-Found, 4200 A (As-Left), 4200 A (118 Days), and -900mV CP Criteria.]
9. Results

![NC ICCP Transformer/Rectifier Readings](image-url)

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[Graph showing NC ICCP Transformer/Rectifier Readings with dates and ampere values]
9. Results

Strategy and Results of an Impressed Current Cathodic Protection Retrofit in the North Sea

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10. Conclusions

✓ Project was successfully completed on time and under budget
✓ The galvanic CP system on a large offshore fixed structure in the North Sea lasted 30 years
✓ The most cost effective method of extending the CP life of a structure of this magnitude is with a remote ICCP system
✓ Polarisation is ongoing and could take another year
Many thanks to TAQA whom allowed me to publish and present this data

Big thanks to the Project Team – Project Manager Ronnie Toal and Lead Project Engineer Graham Woodland

Big thanks to Deepwater

Thanks to Icorr Aberdeen for this opportunity