Retrofit CP Monitoring to Reduce Inspection Frequency

ICORR SPECIAL EVENT ON CATHODIC PROTECTION

Andy Smerdon – MD, Aquatec Group

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Overview

• Introduction to Aquatec
• Offshore CP: The Problems
• Solutions
• Case Study
• Closed Loop Control
• Summary
Aquatec Group Ltd

- Founded in 1990
- Headquartered in Basingstoke UK
- Design and manufacture all products and engineered solutions
- Products sold worldwide
- ICorr Sustaining Member
- ISO9001 - ISO14001
  BS OHSAS 18001
- Design, manufacture and supply of subsea instrumentation, communications, and cathodic protection systems

Customers in the offshore market
Subsea Solutions
Consultancy ● Measurement ● Communication ● Insight

• **Areas of Expertise**
  – Sensing underwater
  – Data acquisition, processing and storage
  – Through- and above-water communication
  – Subsea packaging

• **Technologies**
  – Acoustics
  – Optics
  – Cathodic Protection
  – Temperature & Pressure
  – Motion and Attitude

**Design and Production Skills**
  – Electronics design
  – PCB layout and assembly
  – Mechanical design and assembly
  – Signal processing
  – Software development
  – Calibration
  – Acoustic test
  – Optical test
Cathodic Protection & Monitoring

OFFERING A FULL END TO END CP SERVICE

We will work with you through the life of your asset, delivering advice, protection and monitoring hardware, and technical support.
Offshore CP – The Problems
The Problems

AGING OFFSHORE STRUCTURES

• Original design life based on estimates of reservoir yield
• 5-25 year life extensions now needed because of:
  – Extended discoveries, satellite wells + tiebacks
  – Enhanced oil recovery techniques
• Sacrificial CP on older platforms now depleted and protection is failing
• Older ICCP systems often damaged or failing
• New infrastructure can rapidly drain CP if not carefully assessed
• Regulators require reinstatement of adequate protection levels
The Problems

INSPECTION DIFFICULTIES

• Reliable and consistent data needed to inform decisions
• Sacrificial Anode depletion monitored by subjective Diver/ROV general visual inspection – e.g. “anode 90% depleted”.
  – How is it measured?
  – What was the original size?
• CP potential surveys using Stab Probes
  – Time series generally erratic
  – How to ensure identical year on year physical locations?
  – Carried out in calmer conditions – lower oxygen but higher temperature
  – ROV time = £££
Solutions
Solutions

**CP MONITORING TOOLBOX**

- **Fixed Point CP Potential Monitoring**
  - Provides year-round CP Potentials at exactly the same location in all sea conditions

- **Fixed Sacrificial Anode Current Monitoring**
  - Monitors the current actually delivered to the structure

- **Real-Time Communication Options**
  - Acoustic transmission of real-time data from multiple monitoring locations
  - Optical transmission for rapid time series retrieval
Monitor CP Current

MEASURE ACTUAL PROTECTION CURRENT FROM SACRIFICIAL ANODES

• Measure the voltage across a known low resistance in the current path
• Use isolation joint
  – Insert low value resistive shunt
  – Measure voltage drop on shunt
• Use anode return cable
  – Measured cable resistance
  – Measure voltage drop on cable

\[ I = \frac{V}{R} \]

Cathode (steel) → Shunt → Sea → Anode on Structure → Anode Sled → Return Cable
Monitor CP Potential

MEASURE STEEL SEAWATER POTENTIAL WITH CROSS CHECK

• Use reference electrode as datum to form half cell with the cathode (steel structure)
• Reference electrode
  – Maintains constant potential
• Practical electrodes:
  – $V_1 = \text{Steel re Silver/Silver Chloride}$
  – $V_2 = \text{Steel re Zinc}$
  – $V_2 - V_1 \approx 1.04V$
**CPguardian Potential Monitor**

- **AQUAmodem 500CP** real-time CP potential monitor units

- Measure steel potential with respect to Zinc & Silver/Silver Chloride electrodes

- Transmit data up to every 15 minutes using acoustic telemetry

- Attach with clamps, friction welds, or magnets using diver or ROV
CP guardian Monitor Attachment

• Steel case in contact with cathode (steel platform) through:
  – Mechanical clamping arrangement (ROV or diver installed) 900mm clamp shown, or
  – Mechanical banding, or
  – Friction welding
What is CP\textit{guardian}?

PROVIDING CONTINUOUS FIXED POINT MONITORING FOR ANALYSIS & CONTROL

- CP surveys, whether by ROV or dip cell provide:
  - Infrequent sampling
  - Erratic time series
  - Inconsistent physical locations
  - Only in ideal weather conditions (often best case CP levels)

- CP\textit{guardian} monitor units combine CP potential (or current) measurement & real-time data transmission

- CP\textit{guardian} provides:
  - Frequent updates – hourly or faster
  - Regular sampling – consistent time series
  - Always from the same location
  - All year round
How does CP guardian work?

SIMPLE ACOUSTIC TRANSMISSIONS

• ‘Send and forget’ principle
• Read two potentials or currents every 15 to 60 minutes (according to required battery life) and transmit message
• Message collision avoidance:
  – Two transmissions every update period
  – Separated by random interval
• Message includes error checking and correction
• Decoding includes multiple validation stages to minimise false alarms
• Range up to 800 m
• Typical 15 year life
How do you receive CP guardian data?

MULTI-FUNCTION ACOUSTIC RECEIVER

- Acoustic receiver comprises:
  - Acoustic hydrophone
  - Digital signal processor
  - Memory for logging received data
  - RS232 communications for real-time or stored data recovery

- Deploy from vessel
- Deploy from ROV
- Mount permanently
  - Cable connection
  - Subsea data logger with comms (AQUAmodem Op2)
AQUAmodem Op2
TRANSPARENT OPTICAL COMMS LINK

- Up to 115 kbits/s
- 1-2 m range
- Uses ROV RS232 comms
Case Study
Case Study

CP\textit{guardian} DATA LOGGED CURRENT+POTENTIALS

- UK North Sea platform
- 40 years old
- Requirement for 15 year life extension
- Multiple SACP sleds selected as optimum method
- Regular updates of cathodic protection potentials \textit{and} sled anode current
- All data logged subsea for rapid ROV retrieval
- Real-time data available through dunking acoustic receiver
The Solution

SACRIFICIAL ANODE CATHODIC PROTECTION (SACP)

- 22x SACP Anode Skids (by others)
- All fitted with Current Monitors
- 14x CP Potential Monitors
- 4x Data Loggers & Optical Comms
Complete System

• Potential Monitoring
• Current Monitoring
• Sacrificial Anode CP
• Data logging

Acoustic Receiver

Transmitting

Retrieve logged data

Collect real-time data

Potential Monitor 1 of 14

Sacrificial Anode Skid
Current Monitor + Data Logger 1 of 4

Potential Drop
4 Data Loggers for Redundancy

LOGGERS RECEIVE FROM MULTIPLE TRANSMISSIONS
4 Data Loggers for Redundancy

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4 Data Loggers for Redundancy

LOGGERS RECEIVE FROM MULTIPLE TRANSMISSIONS
Data From Monitor Units

• Most sleds connected to structure during August 2017 as part of a 3 week multi-discipline campaign
• Data downloaded mid-campaign from sleds
• Three potential monitor units installed prior to data download
• Acoustic data acquired at least once daily from all current and potential monitors
• Current data shows initial and stable currents
• Potential data shows protection being restored
• Next data set to be gathered in 2018
Data From Current Monitor Units

2016/08/06 19:18 - 2017/09/10 04:25 Current

Current(A)

0 10 20 30 40 50 60


41 42 43 44 45 46 47 48 61 62 63
Data From Potential Monitor Units
Data From One Current Monitor

Sled 14 Currents

- Blue line: Cable 1 (A)
- Red line: Cable 2 (A)

Dates on the x-axis range from 25/08/2017 to 09/2017.
CPguardian for Closed Loop Control
Why Closed-Loop Control?

- Complex structure can have wide spread of potentials
- Presence of high strength steels, including pipelines, jackup structures, anchor chains
- Delicate balance to meet minimum protection potential while avoiding over-protection
- For a given current, protection will vary seasonally, with changing meteorological conditions, water currents, vessels/jackups alongside, vessel orientation etc
- Cannot do dip cell survey and manually adjust current every few hours!
Closed-Loop Control Concept

• Use model to select locations likely to be most and least protected
• Monitor all potentials with CP\textit{guardian}
  – continuously in near real-time
  – using acoustics
• Adjust current output automatically
• Calibrate system response
• Control current on basis of measured potentials
• Ensure adequate but not excessive protection
CP\textit{guardian} for Closed Loop Control

IMPRESSED CURRENT CATHODIC PROTECTION (ICCP)

- 1-12x ICCP Anode Skids
- 1x ICCP Multi-Bank Power Supply
- 1-24x CP\textit{guardian} Potential Monitors
Complete CP guardian System
Summary
Summary

• Retrofit CP solution for aging offshore platforms and pipelines
• Acoustic comms removes need for cabled monitoring
• Capability for sacrificial current monitoring and logged data retrieval using optical comms
• Combine with
  – Compact and efficient power supplies
  – Easily installed seabed equipment
• Real-time acoustics provides closed-loop control
• A viable CP solution for life of field extension
CPguardian

CATHODIC PROTECTION FOR AGING ASSETS

- System design assessment
- Retrofit CP
- Impressed current systems
- Sacrificial anode systems
- Dual electrode potential monitors
- Current monitors
- Closed loop control systems
- Data retrieval, analysis & insight

Integrity Monitoring

- Real time
- Data logged
- Through-water comms

|               | Vessel/Boots | Structure | Subsea | Production | Flowline | Pipes | Risers | Cables | Moor/Sp
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Thank you - Any questions?