Condition Monitoring System
Offshore structures

*Monitoring environmental and structural Loading of offshore structures*

**FORCE Technology**

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Engineering and structural analysis
Structural Integrity
Structural integrity management
Structural assessment
Structural design limits

Structural limitations - Fatigue

Weld flaw below allowable flaw size

Dynamic load leads to crack growth (fatigue)
Global corrosion - Global reduction of material thickness

Local corrosion - Local reduction of material thickness

Local pitting (self accelerating corrosion process) - Local stress intensities

Corrosive fatigue effects – Reduction of fatigue strength
Structural design limits

Structural limitations – Other factors

Environmental effects
Geophysical effects
Weld quality
Material limitations
Stability limitations
Monitoring
Ensuring structural integrity

Monitoring of estimated residual structural life

Enabling for load time scheduled maintenance plan

Identifying internal and external environment

Monitoring of corrosion rate

Extend operation life in accordance to actual load

![Prediction of Fatigue Life Graph]

- Current state
- Design life
- Point of failure
Data acquisition system mockup
Data acquisition system hardware

System hardware

Measurement computer

Multi-purpose, expandable data acquisition device

Redundant power supply (UPS)
Optional interfaces

Modbus/TCP: Streaming of raw data

Access using a Remote Desktop Connection

System holds a FTP Server

Synchronization to time server (NTP)
Monitoring data acquisition system

Data Acquisition System

- External Sensors
  - Scour Sensors
- Structural Monitoring
  - Strain Gauges
  - Load cells
  - Displacement Sensors
  - Accelerometer
  - Inclinometer
- Environmental Condition
  - Dissolved Oxygen
  - pH Measurement
  - Water Level
  - Water Temp.
- Corrosion Monitoring
  - ER Sensors

Connections:
- Modbus TCP
- FTP Connection
- Remote desktop Connection

Corrosion rate data logger
Structural monitoring

- External Sensors
- Environmental Condition
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- Water Temp.
- Water level
- pH Measurement
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- Strain Gauges
- Load Cells
- Displacement Sensors
- Scour Sensors
- ER Sensors
Environmental condition

- Structural Monitoring
  - External Sensors
  - Environmental Condition
  - Corrosion Monitoring
  - Water Temp.
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- Photographic images of sensors and monitoring equipment.
Corrosion monitoring

Structural Monitoring
External Sensors
Environmental Condition
Corrosion Monitoring
Water Temp.
Water level
Dissolved Oxygen
Accelometer
Inclinometer
Strain Gauges
Displacement Sensors
Load cells
Scour Sensors
ER Sensors
Seabed scour monitoring

**Scour monitor**

Powerful means to obtaining data about the elevation over seabed e.g. a monopile

**Objective**

Detect changes in scour protection around foundations
Data processing
Data transmission

Data acquisition and pre-processing control of:
- Statistical data
- Various temporary storage of data
- Condition monitoring of sub structure

Wind farm Control center / SCADA

Onshore Network

Condition monitoring and alarm system:
- Online post processing
- Interpretation of data
- Reporting
- Alarm handling
- Data storage

Router

Internet

Remote office e.g. FORCE Technology
Data transmission for limited bandwidth

Logging data

Analyzing data

Pre-analyzed data for limited bandwidth data acquisition systems

Pre-analyzed data  Analyzing data

• Limited bandwidth

Pre-analyzed data

Analyzing data

• Limited bandwidth
Rainflow-counting algorithm
Rainflow-counting algorithm

Δσ-N diagram
FORCE Technology

Monitoring solutions for your disposal
FORCE Technology provide following monitoring services

Installation of equipment
Both Onshore and offshore

Data collection and analyzing

Data evaluation by specialists. E.g. corrosion and fatigue life
Structural monitoring
Part of the design
Knowing is part of the future
Implementing monitoring in structural design solutions

Utilize monitoring knowledge to do ongoing design evaluation, and gain lighter structures.

Design close to actual dynamic load.

E.g. 90% - Above design life
     10% - Below design life

10% require further structural evaluation
Post design upgrade, utilizing advanced NDT methods, ensuring structural integrity.
Thank you for your attention

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