Comprehensive Approach to Integrity Assessment of Critical Structural Components with ASPIRE™

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- Well conductor integrity challenges
- What is ASPIRE™?
- Advanced well conductor inspection
- Assessment procedure
- Case study
- Conclusion
Well Conductors

- Offshore well bores consist of several concentric tubes
- The outermost well casing, the conductor, protects the inside casings from aggressive corrosion.

- The conductor should not leak, nor buckle or collapse under both axial load and bending moment
Past Conductor Failures
Well Conductor Integrity Management Challenges

• Ageing assets
• Missing documentation of the asset
• No or insufficient inspection data available
• Lack of advanced technology available for effective cleaning and inspection of vulnerable areas (i.e. splash zone)
• Lack of advanced technology available for processing of the inspection data to provide a risk based condition assessment of the asset
• Lack of assessment application that can be used on site while the inspection is ongoing allowing for immediate decision making
• No means for easy planning of mitigation options (i.e. repair)
What is ASPIRE™?

ASPIRE™ stands for “Assess Strategy for Upstream Plant Inspection and Repair” and is a software package to integrate the collection, management and analysis of inspection data for the purpose of providing RBI and repair decision making for upstream assets.

What ASPIRE™ does:

• Incorporates a customisable probabilistic based algorithm to use advanced reliability methods to assess failure scenarios for several types of non-standard geometries, loading, environment and operations.
• Links the assessment to input from advanced NDT to analyse the results seamlessly.
• Provides information about operational risk and remaining service life as an output.
Advanced Inspection (MEC-MPS200+)

System Set Up arrangement & Power Supply

MEC Computer  Power:
IN: 110V AC, Rated 130W
OUT: ET Board Output DC 12V & DC 5V

DC Power Supply & Sensor Multiplexer
IN: 110V AC
OUT: max DC 40V – 36A

Monitor & DVD Recorder
Camera
IN: 110V AC, ~ 150W
MEC-MPS200+ Inspection Equipment

- Operations
  - Little pipe preparation needed (no couplant)
  - Remote controlled deployment
  - Includes a spray bar for marine growth cleaning based on high pressure jetting

- NDE key points
  - up to 1.3” Wall Thickness, sensitive for isolated pit detection, sizing accuracy ≤ +/- 10%
  - inspection through coatings (Neoprene etc.) & CRA layers (Monel, Inconel, TSA) with the MEC technology
  - also includes an array of UT probes for a simultaneous mapping of the remaining wall thickness (in addition to MEC)
  - inspection speed (net average run speed 0.25m – 0.5 m/sec)
  - separate C-Scan corrosion mapping of near side & far side or merged

- Direct online data assessment & integrity assessing data set up
- Delivers wall thickness matrix data in a neutral format (i.e. csv files)
MEC-MPS200+ Splash Zone Inspection

- Riser / Caissons / Conductors
- Combined cleaning & inspection
- MEC & UT Technology combination
- Inspecting through coatings
- No operational interruptions
- RAT Deployment / remotely operated
WT Matrix Data used as input to assessment

Provided in open data format (i.e. as csv file)
• **Purpose**
  - To demonstrate / document viability & integrity of each of conductors
  - For next “x” years – Endorsement period – Time/Risk Based Inspection period
  - Avoiding any major repairs

• **Process**
  - Review of available data
    - Design analyses and engineering assessments
    - Inspection scopes & results
    - Operational history including incidents
Design check of well conductors is a stability check based on international best practices:


Minimum Required Thickness (MRT) is the thickness below which the required cross sectional area is not achieved and failure may occur.

Grouting in annulus of conductor and other internal casing/tubing will influence the MRT calculation. It will be in-conservative not to consider the effect of grouting.
Assessment Procedure

In summary, design evaluation of conductors include:

- Determine the equivalent section of the conductor by the supports configuration.
- Determine the stiffness of the conductor based on effective length.
- Calculation of the axial loads and bending moment.
- Calculation of stress ratio.

MRT calculation which is the critical thickness at which the stress ratio is equal to 1.0.

**Axial Compression**

**Pi:**
- Axial load due to weight of conductor, internal casings etc.

**Pe:**
- Axial load at each elevation due to weight on top of the conductor

**Global Bending**

**Me:**
- Bending moment due to environmental condition such as “100 year storm – Wave and current” calculated by SACS software

**Mi:**
- Bending moment due to eccentricity of casings
Remaining Life Assessment

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Corrosion Rates

Current Study

According to HSE Research Report 016 - Guideline for use of statistics analysis of sample inspection of corrosion

Estimated CR will be the 95% confidence limit

Literature

Zones of corrosion for Steel Piling in Seawater

Risk and Risk Based Remaining Life

- Predictive target risk date (RLI)
- Inspection frequency determined
### Results per section of conductors

Total of 98 sections from 25 conductors

#### Current Risk

- **Very High**: 5, 1
- **High**: 4, 1
- **Medium**: 3, 2
- **Low**: 25, 28, 33
- **Very Low**:
  - Water Injection:
    - Unmanned: 25
    - Manned or: 28, 33

**Probability**
- Very High: $10^{-2}$
- High: $10^{-3}$
- Medium: $10^{-4}$
- Low: $10^{-5}$
- Very Low

**Consequence**
- Unmanned
- Manned or

#### Forecasted Risk In 7 Years

- **Very High**: 9, 2, 2
- **High**: 2, 2, 2
- **Medium**: 1, 1, 2
- **Low**: 4, 2, 3
- **Very Low**: 15, 22, 25

**Probability**
- Very High: $10^{-2}$
- High: $10^{-3}$
- Medium: $10^{-4}$
- Low: $10^{-5}$
- Very Low
Proposed methodology:

**Method 1:** Applying a reduction strength factor.

**Method 2:** Define distance criteria between two patches of corrosion.
ASPIRE™ Software – Data Handling

ASPIRE - Assess Strategy for Upstream Plant Inspection and Repair

- Easy to use
- Produces assessment results by click of a button
- Allows visualisation of input data (i.e. wt matrices)
- Allows for arbitrary sets of input parameters to simulate different scenarios
- Allows managing all conductors forming part of the asset base

![Properties: Consequence of Failure](image-url)
Verification of Input
Risk Assessment

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Probability of Failure after Repair

Component: Conductor A05
Repair in 2018

Risk Assessment

Defect

Repair patch

Reduction in Probability of failure

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Conclusions and Summary

- ASPIRE™ software package enables criticality assessment of conductors based on the results from advanced inspection
- Based on a proven and transparent methodology for conductor integrity assessment
- Calculates Probability of Failure based on input from inspection data
- Helps determining Risk-Based Remaining Life of the Conductor
- Allows optimising re-inspection periods
- Helps prioritising repair work based on a risk ranking of different conductors inspected
- ASPIRE™ assessment can be done on site with the inspection results collected
Thanks for your attention.
Any questions?

About the Project Partners:
- Innospection: Service provider to the O&G industry for advanced automated inspection
- TWI: one of Europe’s largest independent research & technology organisations. Non-profit membership based non-profit organisation with 3,500 members from 60 countries.