Flexible Riser Life Extension with FlexIQ

S. Hartmann, Innospection Ltd., Aberdeen, UK
Dr. K. Reber, Innospection Germany GmbH, Stutensee, Germany
Dr. K. Oliver and Alessandro Lagrotta, INTECSEA, Woking, UK
Dr. Arya Majed and Nathan Cooke, INTECSEA USA
Ahmed Alli, FADFAE Engineering Services Ltd., Lagos, Nigeria

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What is FlexIQ?
Case Study - Project Overview

Scope of Work (related to red highlighted sections):
- Marine growth cleaning
- Inspection – 100% scanning with MEC-Hug tool
- Integrity assessment of the tensile armour wires using the FLEXAS™ numerical solver
- Risk Based Assessment (to look at all other components of the flexible riser system)
## Case Study – Riser Details

<table>
<thead>
<tr>
<th>Specification</th>
<th>Middle Riser</th>
<th>Lower Riser</th>
</tr>
</thead>
<tbody>
<tr>
<td>Riser ID</td>
<td>18.75”</td>
<td>18.75”</td>
</tr>
<tr>
<td>Riser OD</td>
<td>23”</td>
<td>23”</td>
</tr>
<tr>
<td>Total Length</td>
<td>2,240m</td>
<td>2,240m</td>
</tr>
<tr>
<td>Buoyancy Section Length</td>
<td>1,080m</td>
<td>1,026m</td>
</tr>
<tr>
<td>Length Inspected</td>
<td>2 x 580m</td>
<td>2 x 607m</td>
</tr>
<tr>
<td>Inner Tensile Lay Angle</td>
<td>54.8 degrees</td>
<td>54.8 degrees</td>
</tr>
<tr>
<td>Outer Tensile Lay Angle</td>
<td>55 degrees</td>
<td>55 degrees</td>
</tr>
<tr>
<td>Tensile Wire Thickness</td>
<td>3.6mm</td>
<td>3.6mm</td>
</tr>
</tbody>
</table>
Marine Growth Cleaning

- “Cheese wire system”
- ROV based
- Cleaning completed in 4 days (working day and night shift)
MEC-FIT Inspection – Order of Scanning

Buoyancy

FPSO / SPM

Section 1

Section 2

Scan Direction
MEC-FIT Inspection

- Inspection completed in 16 days (working day and night shift)
Larger tensile wire gapping within the inner layer.
Reoccurring pattern at the pitch length of the outer tensile layer (that corresponds to the helical step of the wiring).
FLEXAS™ Numerical Simulation

- Allows accurate computation of tensile armour wire stress time-histories.
- Takes into account mechanical stimulation by irregular waves (possible through a finite element model using Nonlinear Dynamic Sub-structuring).
- Modelling technique
  - Global model: system level simulation
  - Local model: high fidelity simulation of an isolated section
- Lower flexible BOOR section near the SPM hang-off is selected for further detailed local analysis.
The lower bound fatigue life estimate is 27.2 years.
Layer by Layer Risk Based Assessment (RBA)

- Identifying and assessing degradation threats in a logical manner for each layer of the flexible (all credible degradation mechanism from API 17 N are considered).

- Assessment of “non-inspectable” layers (such as carcass, internal plastic sheaths) which are important to the integrity of the flexible.

- Allows to select specific mitigation actions to keep the risk level to ALARP (As Low As Reasonable Practicable).
Layer by Layer Risk Based Assessment (RBA)

Three high risk elements:
- TA1: single or multiple wire rupture
- C2: carcass collapse
- EF5: vent blockage
Conclusions

– The FlexIQ approach demonstrates that combining methods of advanced inspection and analysis as part of an integrity assessment is a valid solution for increased understanding of flexible riser condition as part of a life extension program.

– Life extension of flexibles beyond design life depends primarily on the flexible pipe condition, rather than it’s age.

– The FlexIQ approach has demonstrated that life extension can be achieved by implementing a comprehensive risk based integrity plan that includes routine inspections, monitoring and maintenance activities.