Structural Life Extension Study

FEA Based Corrosion Processing and Structural Optimization to Minimize Steel Renewal
Problem Statement: Excessive Corrosion identified in Class Special Survey. Several Areas with Scantling under Substantial or Renewal Thickness

Decision Point: Can Re-Assessed FPSO Gross Scantling reduce required thickness, and minimize renewal?

Output Results: Use Re-Assessed FPSO Gross Scantlings to Calculate Substantial and Renewal Thickness, and Revise Steel Renewal Plans

~50% Reduction in Renewal Steel Weight

Process gauging report to visualize the location and extent of corrosion and renewal
Reassessed Scantlings - Definitions

Design Criteria

Survey after Construction

- $t_{as-built}$
- $t_{FPSO\_Gross}$
- $t_{FPSO\_Net}$
- Margin
- ABS NDCV
- ABS ISE Net Requirement

- $t_{At\ Gauging}$
- Margin
- Future Corrosion
- % Allow Wastage
- 75%
- 25%
- Renewal Thickness ($t_{Renewal}$)
- Substantial Thickness ($t_{Substantial}$)
- Margin

% Allow Wastage

Substantial Thickness

Renewal Thickness

Future Corrosion

Margin

Design Criteria

Survey after Construction
Step 1 - Corrosion Input and Processing
SAGA - FEA Model Based Corrosion Input
SAGA Corrosion Processing
Global Model Corrosion Processing

As Built Thickness

Allowable Diminution at Gauging

Actual Diminution at Gauging
Steel Renewal Estimate – Main Deck
### Scantling Reassessment - Optimization

#### ABS ISE Software

---

#### ABS HGSA Software

---

#### Steel Renewal Tables

---

<table>
<thead>
<tr>
<th>Upper Deck Plating in way of Cargo Tanks (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Frame Location</strong></td>
</tr>
<tr>
<td>---------------------</td>
</tr>
<tr>
<td>157-121</td>
</tr>
<tr>
<td>127-142</td>
</tr>
<tr>
<td>112-171</td>
</tr>
<tr>
<td>157-172</td>
</tr>
<tr>
<td>149-112</td>
</tr>
<tr>
<td>157-172</td>
</tr>
<tr>
<td>172-187</td>
</tr>
<tr>
<td>202-238</td>
</tr>
<tr>
<td>232-262</td>
</tr>
<tr>
<td>262-292</td>
</tr>
<tr>
<td>292-320</td>
</tr>
<tr>
<td>262-322</td>
</tr>
<tr>
<td>327-322</td>
</tr>
<tr>
<td>327-337</td>
</tr>
<tr>
<td>337-353</td>
</tr>
<tr>
<td>352-361</td>
</tr>
<tr>
<td>367-377</td>
</tr>
<tr>
<td>377-381</td>
</tr>
</tbody>
</table>

**Notes:**
- **Material Type:**
  - **MILD:** Mild Steel
  - **HT36:** High Tensile Steel 36
- **Conversion Thickness:**
  - **6.35 mm**
  - **6.35 mm**
- **Steel Renewal Tables**
  - **Upper Deck Plating**
  - **Cargo Tanks**
  - **Material Types:**
    - **HT36**
    - **MILD**
  - **Thicknesses:**
    - **17.00 mm**
    - **17.00 mm**
  - **Anticipated Corrosion:**
    - **0.50 mm**
    - **0.50 mm**
  - **Substantial Thickness:**
    - **10.20 mm**
    - **10.20 mm**
  - **Allowable Corrosion Percent:**
    - **20%**
    - **20%**
  - **Allowable Thickness:**
    - **10.70 mm**
    - **10.70 mm**
  - **Reassessment Op:**
    - **ABS HGSA**
Reassessed Scantling Verification

FEA Fatigue Verification

FEA Strength Verification
Renewal Update for Reassessed T

- FPSO Gross Thickness
- As Gauged Thickness
- Structure Under Substantial Thickness
Steel Renewal Update – Tank 2S Main Deck

Before Scantling Optimization

After Scantling Optimization
Summary & Conclusions

• Numerous FSO / FPSOs are experiencing corrosion at a rate exceeding the expectations used at conversion

• Excessive corrosion threatens the feasibility and class approval of the hull structure

• Steel renewal options are limited, and expensive:
  – Steel renewal offshore - ~$50,000 per mT of steel renewal
  – Leave operating site for ship repair yard

• Most Conversion FSO / FPSOs have some level of excessive strength margin

• Scantling Reassessment / Optimization can be an effective tool to reduce or eliminate steel renewal, but requires:
  – A proven method of processing the gauging data to identify the location and extent of excessive wastage
  – The experience to find the right balance between scantling reduction and hull strength / fatigue life