Looking Ahead: Riser System Integrity Management in the GoM

June 2011
Agenda

- Deepwater Gulf of Mexco riser lifecycle;
- Background
- Riser systems sectioning;
- Section criticality vs. integrity management maturity;
- Review of key threats the issue and some recommendations;
- Conclusions.
Riser Lifecycle

- Single Line Offset Riser 1 year*
- Flexible Riser 10 years*
- Top Tensioned Riser 15 years*
- Steel Catenary Riser 17 years*
- Assumed design life

*Current age of first riser type installed

(Documented system failures)
Background

- Integrity Management has been in place to address operational issues;
- Recent events have sharpened the focus;
- Integrity Management has developed as its own discipline within the GoM;
- Emergence of common processes and specialized Engineers trying to anticipate threats rather than respond to problems;
- This presentation sets out to review key risks and evaluate our readiness, or maturity, to address them.
Evaluation Criteria

- Sectioned systems for discreet evaluation;
  - 3 Riser types (TTR, SCR, Flexible)
  - 18 Sections
  - 13 Threats
- 53 Sections to evaluate, rank, and plot;
  - Completed a typical qualitative risk assessment for each section
  - Criticality is the result of plotting probability against impact
  - Evaluated the maturity of industry through 6 equally weighted questions
    1. Is the failure mechanism **well** understood? (predictable)
    2. Can it be designed against?
    3. Can it be mitigated during operation? (easy to control/repair)
    4. Can it be monitored? (data acquisition & processing)
    5. Can the degradation be discreetly measured? (determine MTTF)
    6. Do we (industry) regularly implement barriers/inspections?
- Will review highest ranked sections in detail.
## Key Areas for IM Technology Development

<table>
<thead>
<tr>
<th>No.</th>
<th>Riser</th>
<th>Section</th>
<th>Threat</th>
<th>Criticality</th>
<th>Maturity</th>
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<tbody>
<tr>
<td>2</td>
<td>SCR</td>
<td>Above water hull piping</td>
<td>External corrosion</td>
<td>Very High</td>
<td>Very High</td>
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<tr>
<td>3</td>
<td>SCR</td>
<td>Above water hull piping</td>
<td>Internal corrosion</td>
<td>Very High</td>
<td>Very High</td>
</tr>
<tr>
<td>9</td>
<td>SCR</td>
<td>Flexjoint</td>
<td>Material degradation</td>
<td>High</td>
<td>Very Low</td>
</tr>
<tr>
<td>11</td>
<td>SCR</td>
<td>Straked riser section</td>
<td>VIV Fatigue</td>
<td>Very High</td>
<td>Very High</td>
</tr>
<tr>
<td>15</td>
<td>SCR</td>
<td>TDP region</td>
<td>fatigue</td>
<td>High</td>
<td>Low</td>
</tr>
<tr>
<td>27</td>
<td>TTR</td>
<td>Upper riser at tensioner</td>
<td>Overstress/Fatigue</td>
<td>High</td>
<td>Low</td>
</tr>
<tr>
<td>32</td>
<td>TTR</td>
<td>Upper riser in aircan</td>
<td>External corrosion</td>
<td>High</td>
<td>Very Low</td>
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<tr>
<td>34,35</td>
<td>TTR</td>
<td>Upper riser in aircan</td>
<td>Overstress/Fatigue</td>
<td>Medium</td>
<td>Very Low</td>
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<tr>
<td>36</td>
<td>TTR</td>
<td>Keel joint in aircan</td>
<td>Overstress</td>
<td>Medium</td>
<td>Very Low</td>
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<tr>
<td>54</td>
<td>Flexible</td>
<td>Internals</td>
<td>Internal corrosion</td>
<td>Low</td>
<td>Very Low</td>
</tr>
</tbody>
</table>
**Issue**
- Single barrier and proximity to personnel
- Insulation and coating transitions can act as incubators
- Topsides coupons often in co-mingled fluids
- Chemical injection rates alone may be misleading

**Recommendation**
- Regular topsides inspection (incl. ropes access)
- Improved Coatings
- Guided Wave Ultrasonics
- Develop on-line methods for in-process corrosion prediction
- Develop approach for pigging un-piggable lines
**Issue**

- Premature degradation of the elastomer
- Failure is difficult to predict, no method of monitoring
- Surface cleaning with close visual inspection is only indicator

**Recommendation**

- Develop failure prediction methods based on P&T data [1]
- Improve CVI tools and modeling methods
- Improved elastomeric materials
- Implement learning's from drilling riser elastomers
Straked Riser Sections VI V

Issue
- Strakes foul with marine growth
- Fouling is near surface...i.e. the high current regions
- Have seen complete fouling in 3-5yrs
- Growth over 1/3rd fin height begins to reduce suppression efficiency [2]

Recommendation
- Develop efficient and effective cleaning tools
- Improve anti-fouling treatments
- Evaluate fouled fairing performance
SCR Touch Down Point Stress & Fatigue

Issue
- Increasing depth, HPHT; increased fatigue complexity and sensitivity
- Limited validation of design assumptions (i.e. environment, response, seabed/flowline)
- Difficult to process real time data
- Difficult to measure degradation

Recommendation
- Mature ILI tools for ‘unpiggable’ lines
- Develop methods for accumulating long term fatigue
- Marginal designs should implement data monitoring to validate assumptions [3]
- Know what a leak ‘looks like’ for sub-ambient risers
Issue
- Platform centralizers back off or degrade
- Bending moments in upper sections optimized by centralizer location
- Topside tree mass can have a ‘flagpole’ effect on upper stem/riser

Recommendation
- Centralizers are a key system component, conduct regular inspections [4]
- Process data from load sensors for trends or degradation
TTR Riser Within Stem Stress, Fatigue, and Corrosion

**Issue**
- Riser bending moments optimized by centralizer location
- No direct inspection methods
- Condition of riser or environment inside aircan/stem is unknown
- Interface loads with the hull [5]

**Recommendation**
- Access and methods for regular inspection
- Verification of as installed condition with centralizer locations
- Process data from load sensors for trends or degradation
Flexible Internal & External Corrosion

Issue
- Degradation methods difficult to predict or measure
- Few early warnings from external visual inspections
- Annulus volume testing is subjective

Recommendation
- Improve reliability and accuracy of volume tests
- Corrosion modeling or methods to predict onset of corrosion
- Embedded fiber optics for monitoring
- External inspection/scanning tools [6]
- Acoustic monitoring
Conclusions

- Anticipate an increase in end-of-life (wear out) failures;
- Transition points are emerging as key areas for integrity threats;
- Need to mature the monitoring systems available for deepwater systems;
- Need to improve/develop methods for real time assessment of accumulated stress, fatigue, and corrosion;
- Designs should include capacity for inspection or long term monitoring methods;
- Design consideration for mitigation and/or replacement.
Other Challenges Ahead

- Common standards will be key to driving dialog (common language) and methods (common approach);
- IM should be a consideration in design, and a budget line item in operations;
- A common database of industry failures will yield more relevant risk assessments;
- Personnel will be light (gap in the 35-45 yr technical leaders).
Questions?
1. DOT 2005-Session 23 Riser SCR 3 – “Advances in the Design and Application of SCR FlexJoints®”; Mike Hogan, Scott Moses, and Ralph Dean, Oil States Industries Inc.; 2005
6. “A Unique Approach to Subsea Engineering & Flexible Riser Integrity”; Braemar Steege and Craig Keyworth of flexlife; 2010
Thank you

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