2H offshore

Riser & Conductor Engineering

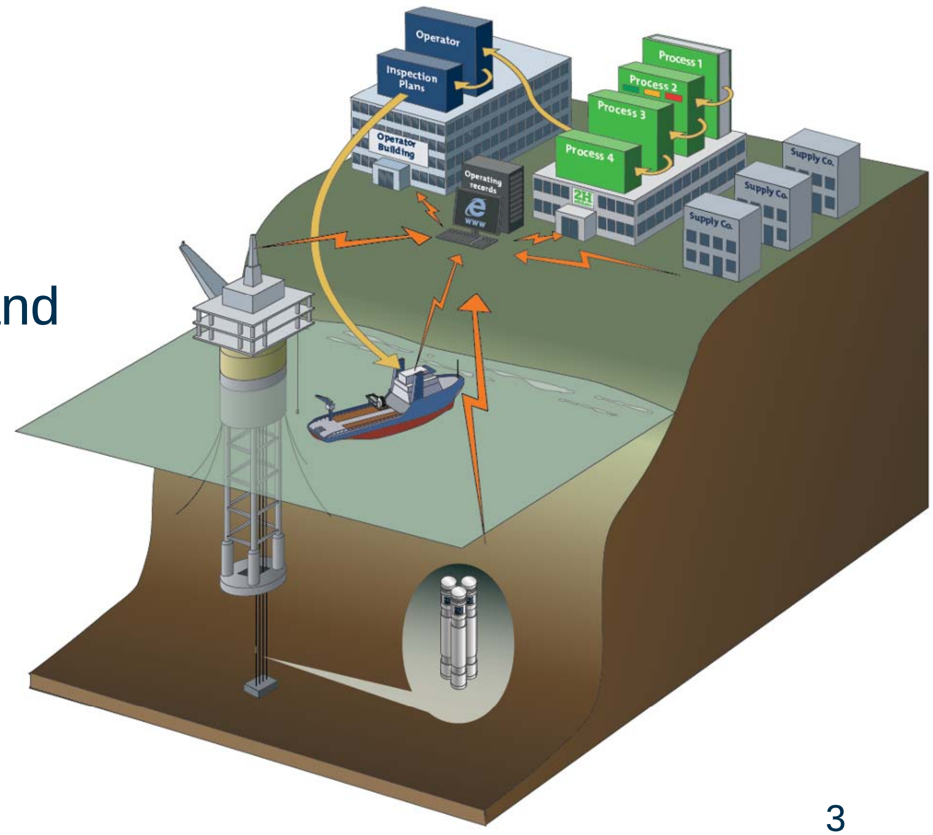
Houston | Rio de Janeiro | London | Aberdeen | Kuala Lumpur | Perth

Looking Ahead:
Riser System Integrity Management in the GoM

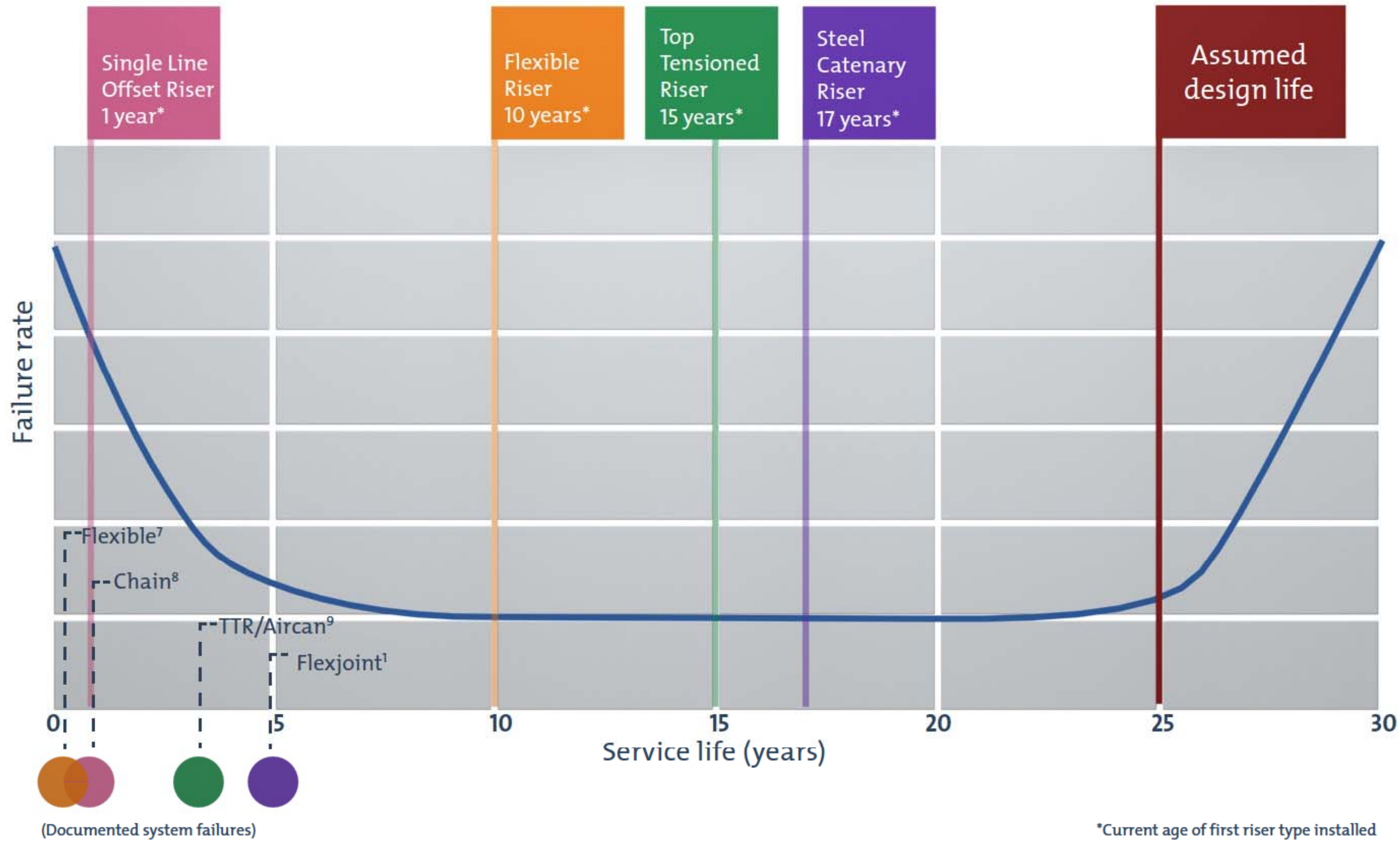
June 2011

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



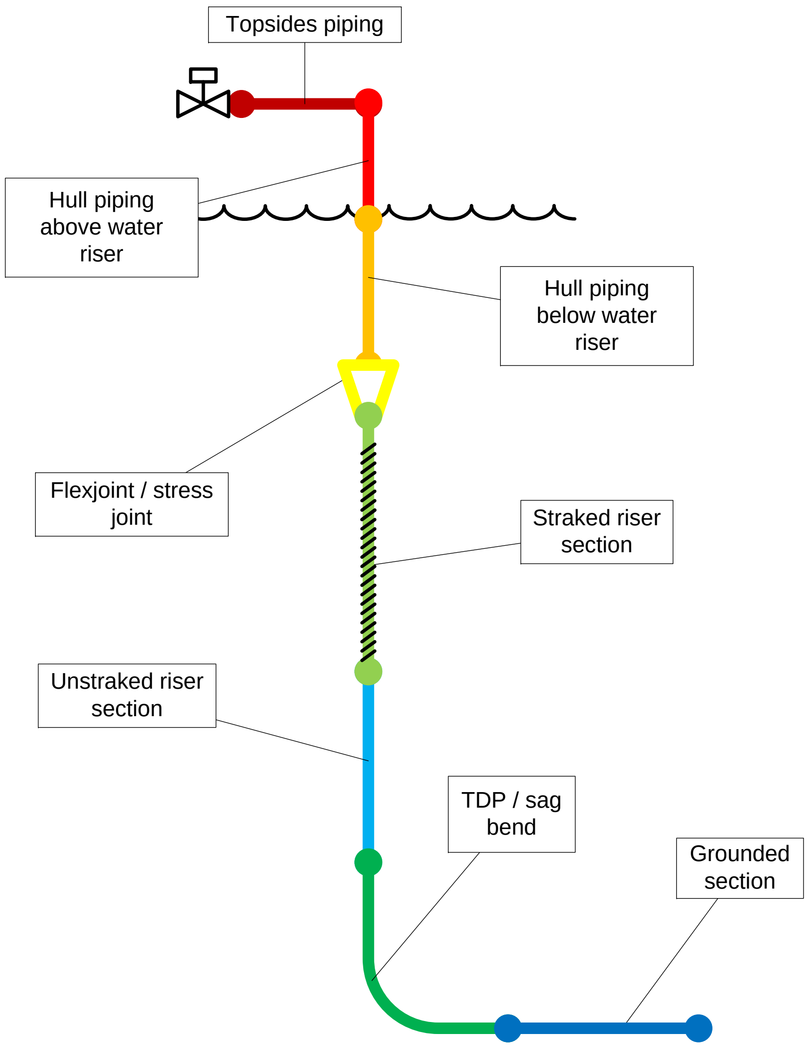
*Current age of first riser type installed

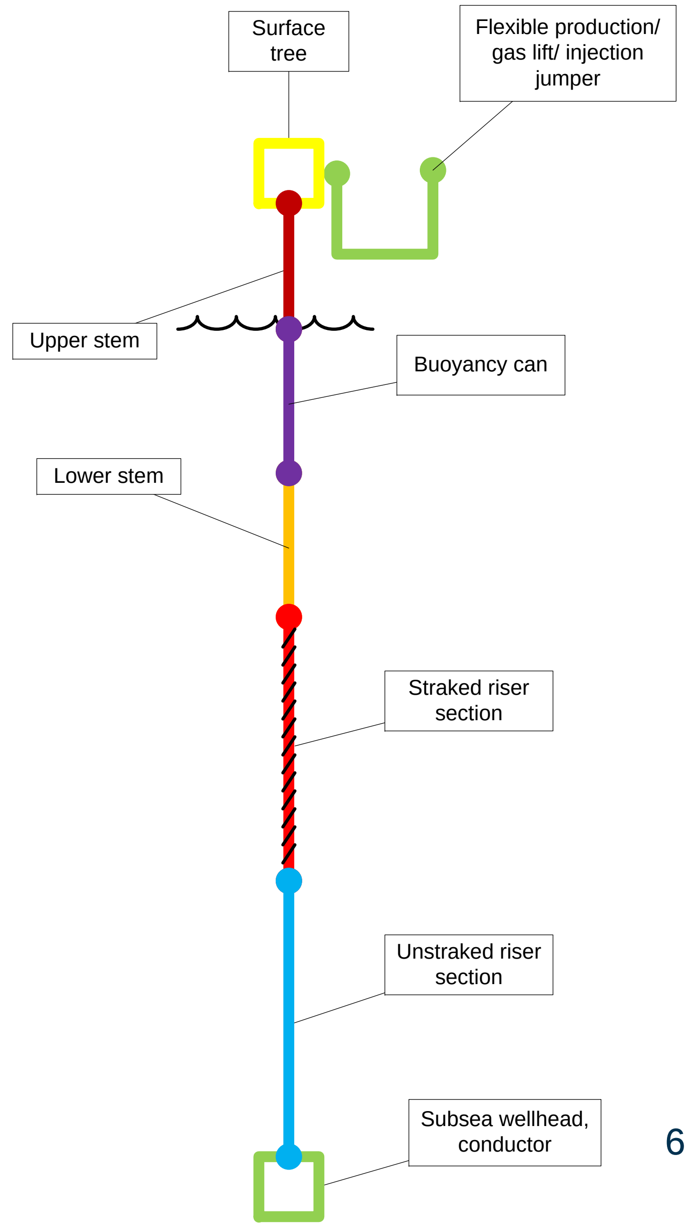
2H offshore

Background

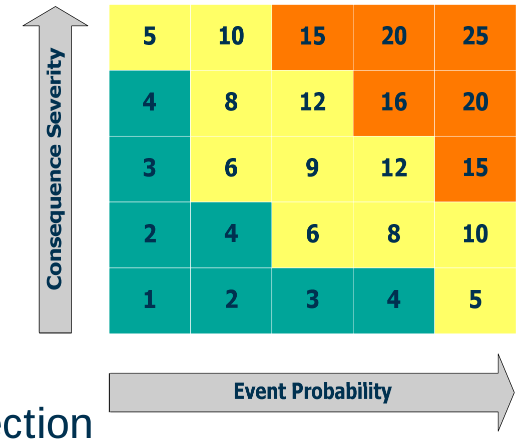
- Integrity Management has been in place to address operational issues;
- Recent events have sharpened the focus;
- Integrity Management has developed as its own discipline within the GoM;
- Emergence of common processes and specialized Engineers trying to anticipate threats rather than respond to problems;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

Primary Sections (Nodes)



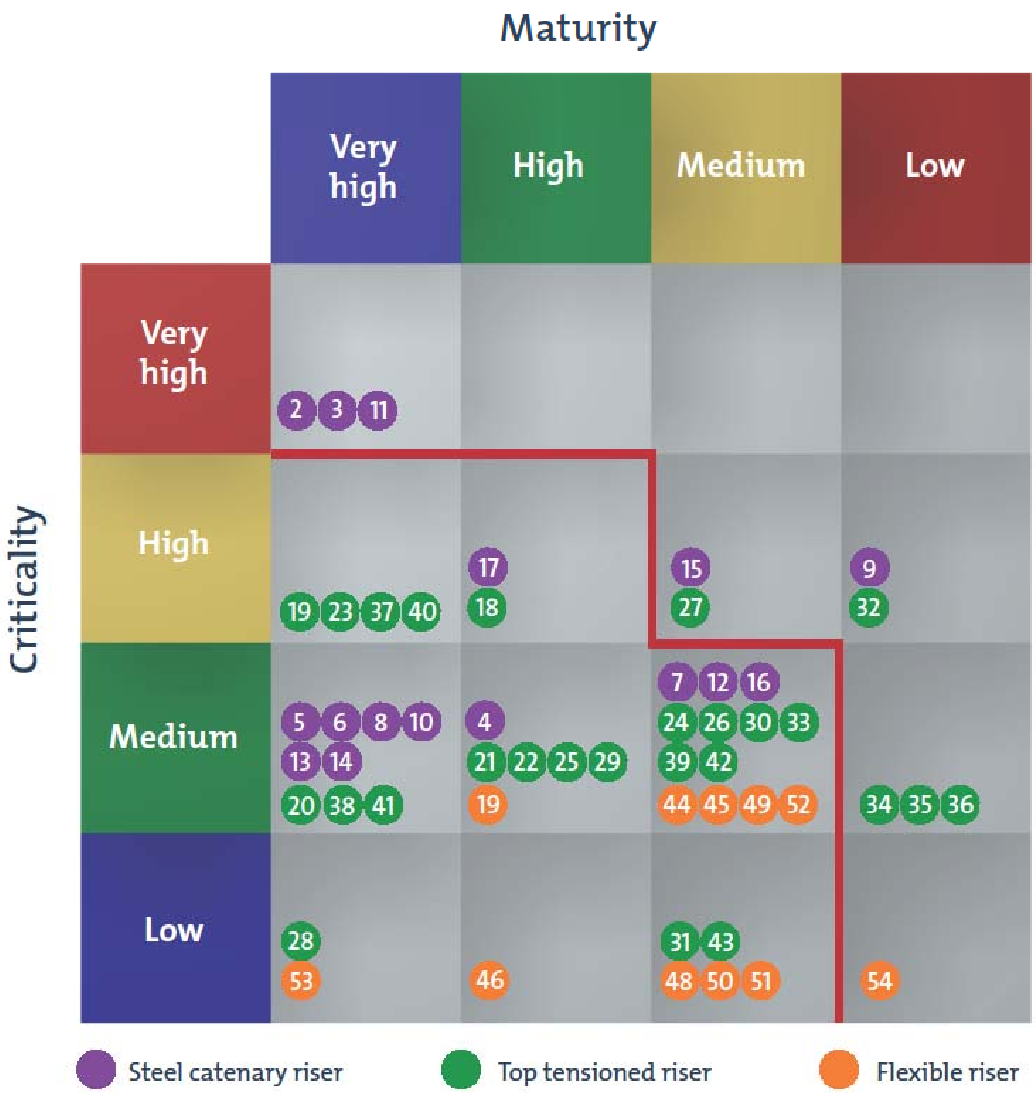


Evaluation Criteria



- 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 <u>well</u> 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.

Criticality & Maturity Matrix



Key Areas for IM Technology Development

No.	Riser	Section	Threat	Criticality	Maturity
2	SCR	Above water hull piping	External corrosion	Very High	Very High
3	SCR	Above water hull piping	Internal corrosion	Very High	Very High
9	SCR	FlexJoint	Material degradation	High	Very Low
11	SCR	Straked riser section	VIV Fatigue	Very High	Very High
15	SCR	TDP region	fatigue	High	Low
27	TTR	Upper riser at tensioner	Overstress/Fatigue	High	Low
32	TTR	Upper riser in aircan	External corrosion	High	Very Low
34,35	TTR	Upper riser in aircan	Overstress/Fatigue	Medium	Very Low
36	TTR	Keel joint in aircan	Overstress	Medium	Very Low
54	Flexible	Internals	Internal corrosion	Low	Very Low

SCR Above Water Hull Piping Internal & External Corrosion

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

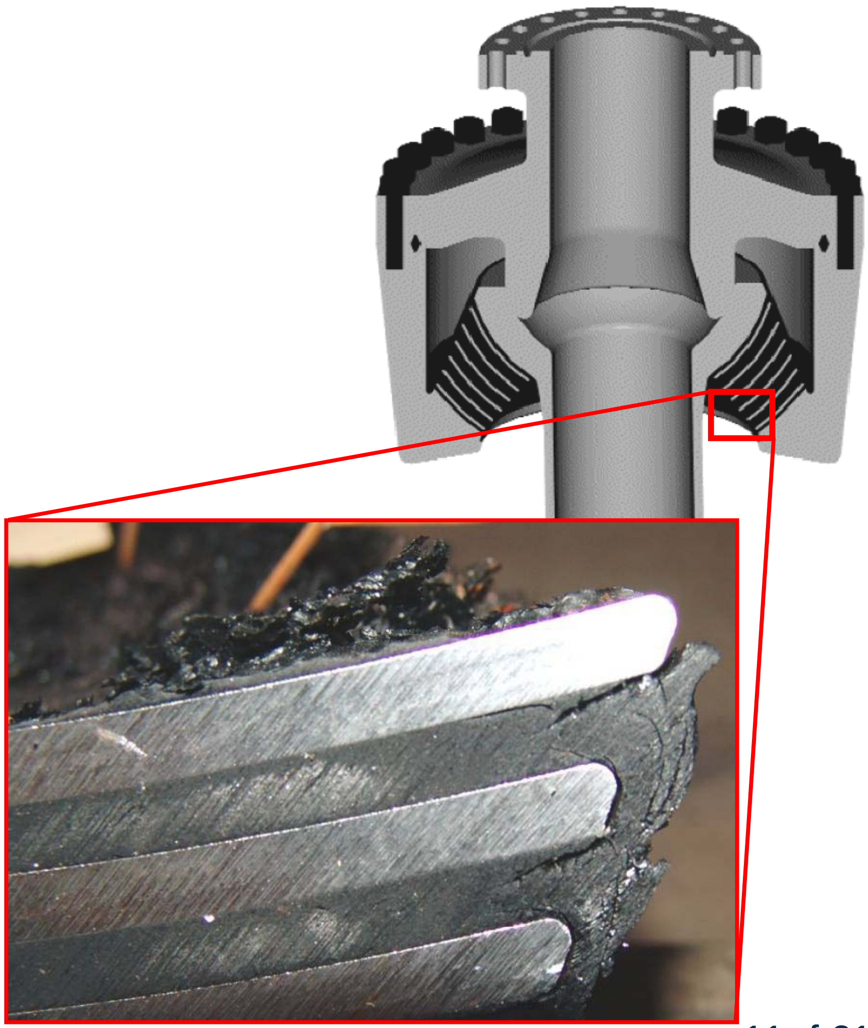
Recommendation

- 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

SCR FlexJoint Degradation

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 VIV

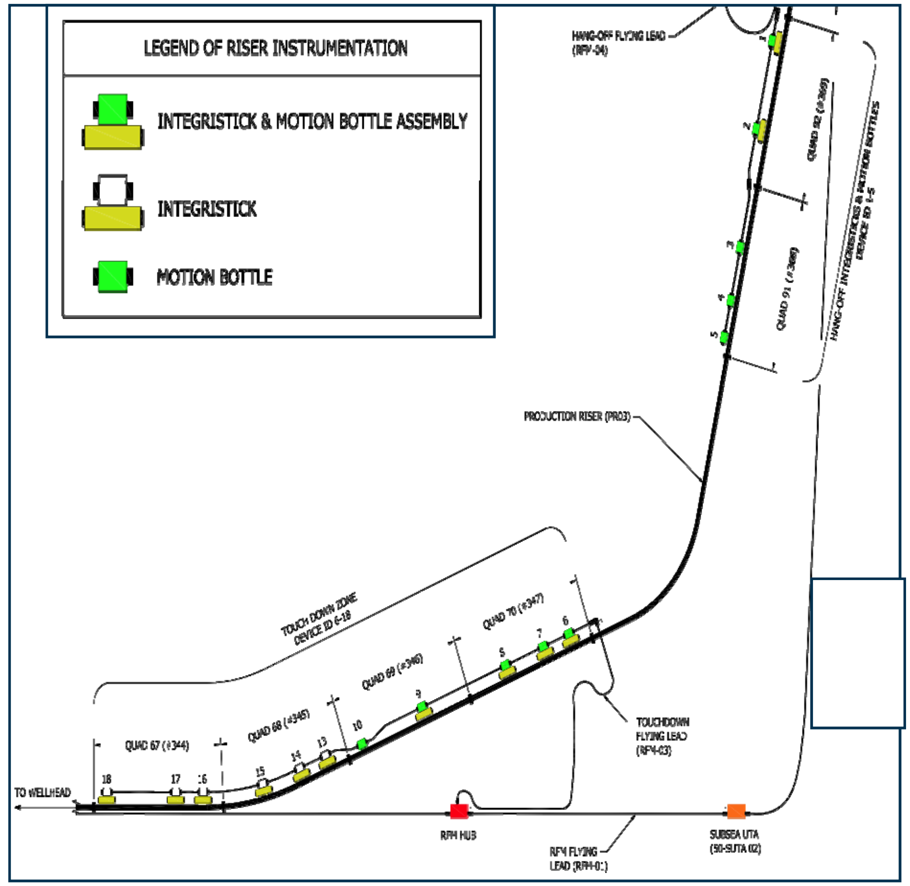
Issue

- 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



<u>Issue</u>

- 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

<u>Recommendation</u>

- 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

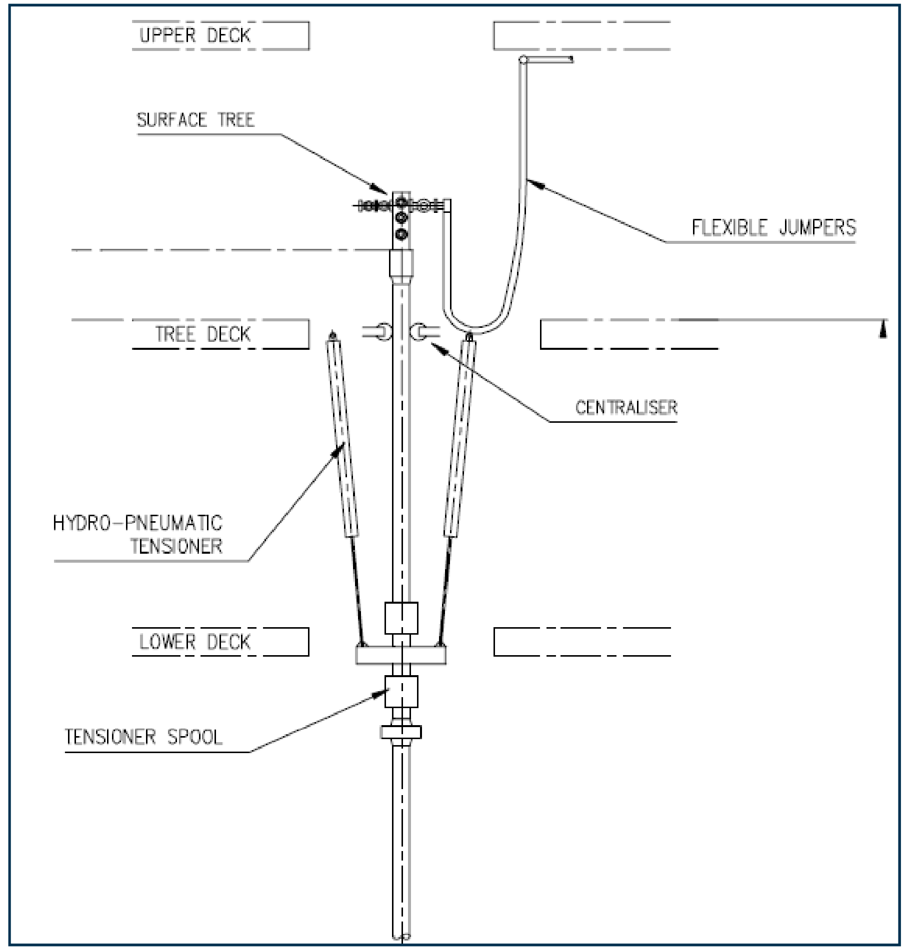
TTR Upper Riser Stress & Fatigue

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

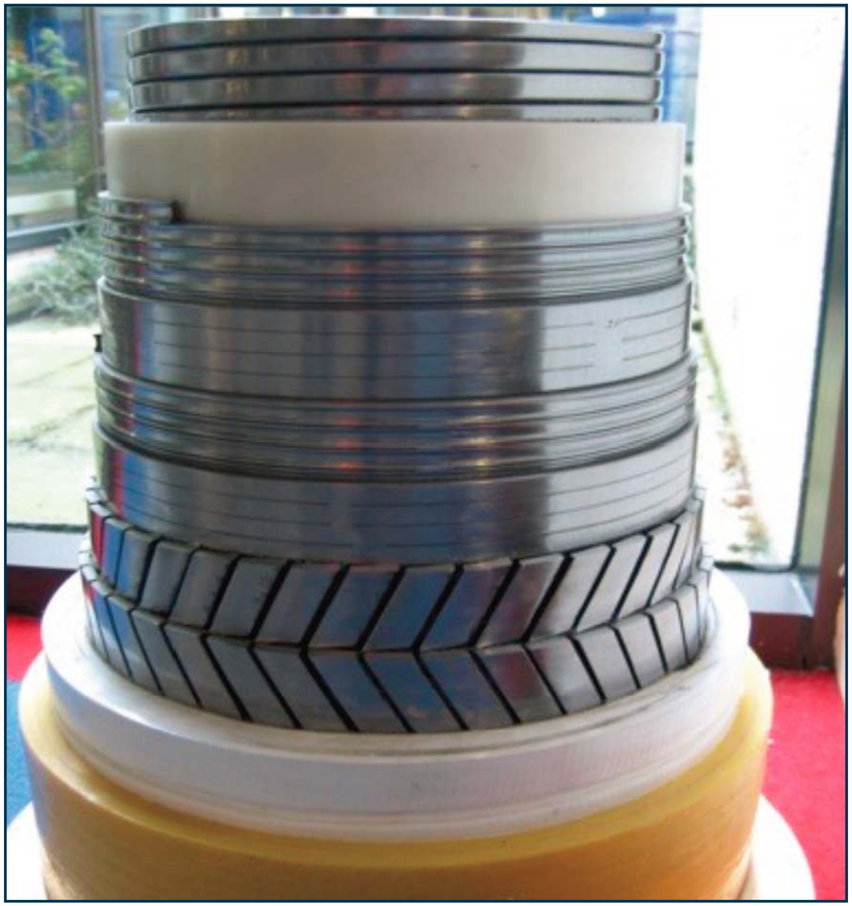
Flexible Internal & External Corrosion

Issue

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

Recommendation

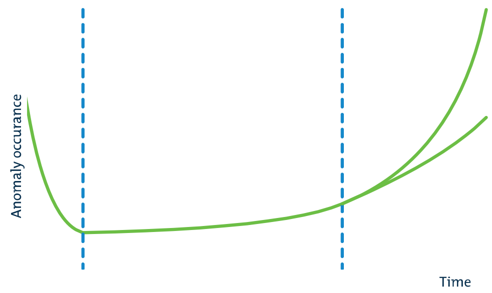
- Improve reliability and accuracy of volume tests
- Corrosion modeling or methods to predict onset of corrosion
- Embedded fiber optics for monitoring
- External inspection/scanning tools [6]
- Acoustic monitoring

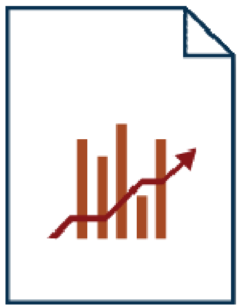


2H offshore

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.





2H offshore

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?

References

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
2. OMAE 2008-57586 – “Effect of Marine Growth on an Elastically Mounted Circular Cylinder”; Kjetil Skaugset of StatoilHydro Research Center and Rolf Baarholm of MARINTEK; 2008
3. OTC-21912-PP – “SCR Integrity Management Program using Field Data from a Monitoring System”; P. Enuganti, and P. Shakkari of 2H Offshore Inc, Y. Constantinides, J. Chen and J. Garaudy, of Chevron; 2011
4. Floating Production Systems 2004-087 – “Design and Optimization of Top Tensioned Risers for Ultra Deep Water”; David Walters, David Thomas, and Stephen Hatton of 2H Offshore; 2004
5. OTC 2003-15385 – “Horn Mountain Spar Risers – Evaluation of Tension and Installation Requirements for Deepwater Dry Tree Risers”; E.J. O’Sullivan of MCS, R.B. Shilling of BP, A.D. Connaire and F.W.A. Smith of MCS; 2003
6. “A Unique Approach to Subsea Engineering & Flexible Riser Integrity”; Braemar Steege and Craig Keyworth of flexlife; 2010
7. Offshore Energy Today – “USA: Anadarko delays production from Caesar/Tonga due to riser system issues”; Retrieved April 25th from http://www.offshore energytoday.com/usa-anadarko-delays-production-from-caesartonga-due-to-riser-system-issues/
8. gCaptain – “Setback in the Gulf for Petrobras: BW Pioneer drops a production riser, Cascade and Chinook shut in (Update)”; Retrieved April 25th from http://gcaptain.com/setback-gulf-petrobras-pioneer?23576#
9. Upstream – “Genesis changes put setback in past”; Retrieved April 25th from http://www.upstream online.com/hardcopy/article44392.ece?mobile=&lots=SITE

Thank you

2H offshore

www.2hoffshore.com