Subsea Integrity Practices in GoM

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SPE Applied Technology Workshop
Oct. 2011
Subsea Integrity Practices in GoM – A Case Study

Session 9: HSE
SPE Workshop
21st October 2011

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Objectives

- Integrity Management Philosophy
- Performance Assessment Methods
- Integrity Issues and Mitigation Strategy
- Summary
Integrity Management Philosophy

- Assure fitness-for-purpose of the subsea system
- Compliance with regulatory requirements
- Effectively manage –
  - Risk to personnel safety
  - Risk to environment
  - Availability of asset
- Address threats arising from –
  - Internal (Corrosion, Erosion, Blockage, etc.,)
  - External (Corrosion, Impact, Structural Stress/Fatigue, etc.,)
  - Ageing related problems
  - Environment uncertainties

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IM Procedure

- DFI Dossier
- Inspection data
- Monitoring data
- Operational experience

Risk based IM Plan

- Inspection Requirements
- Monitoring
- Mitigation Needs
- Operational Limits

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Performance Assessment Methods

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Performance Assessment Methods

1: Direct

2: Indirect

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Integrity Issues and Mitigation Strategy

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Failure Modes

- **Internal**
  - Internal corrosion – SSCC, HIC, CO2 corrosion
  - Erosion
  - Blockage – wax and hydrates
  - Polymer degradation
- **External**
  - Structural overstress
  - Structural fatigue
  - External corrosion
  - Impact
  - Structural wear-centraliser

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Issue 1 – Environmental Uncertainties

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Issue 1 – Track Environmental Records

- Environment record tracked against design limits
- Identify the events that exceed design limits for further investigation

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Issue 2 – Riser Vortex Induced Vibrations (Failure Mode - Fatigue)

Target KPI - Extreme Loads, Long-term fatigue

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Issue 3 – Flexible Riser 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
- Acoustic monitoring

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Issue 4 – Installation Issues

• Issue
  • High surface wellhead bending moments
  • Estimated fatigue life reduced to 2 yrs from 20 yrs

• Cause
  • Missing centraliser during installation

• Recommendation
  • Retrofit foam centralisers
  • Continuous monitoring of wellhead bending moments
Issue 5 – Material Degradation

- Issue
  - Flexjoint elastomer deterioration
  - Increased fatigue and extreme loads at riser-vessel interface
- Source
  - Prolonged exposure to high temperature/pressure

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**Issue 5 – Material Degradation**

- **Recommendation**
  - Develop failure prediction methods based on P&T data
  - Improve CVI tools and modeling methods
  - Improved elastomeric materials
  - Implement learning's from drilling riser elastomers

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Issue 6 – Coating Breakdown (External Corrosion)

• Issue:
  • External corrosion

• Cause:
  • Installation damage
  • Coating application procedure

• Recommendation:
  • Monitor CP readings
  • Surface preparation is key to effective long term coatings, which is the barrier to external corrosion
  • Design should consider extending the coating to reduce coating transitions

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Issue 7 – Cathodic Protection Premature Depletion (External Corrosion)

• Issue:
  • Insufficient cathodic protection and hence external corrosion

• Cause:
  • Inadequate CP design
  • Increased current drawn from other components that should have been electrically isolated

• Recommendation:
  • Monitor CP readings (not always reliable)
  • Retrofit anodes, if depleted
  • Guided Wave Ultrasonics
  • Develop on-line methods for in-service corrosion prediction
Issue 8 – Marine Growth

• Issue:
  • Loss of VIV suppression efficiency
  • Increased drag on the system

• Recommendation:
  • Regular cleaning of marine growth
  • Develop efficient and effective cleaning tools
  • Improve anti-fouling treatments
  • Evaluate fouled fairing performance
Issue 9 – Flowline Snagging

Issue
- Remaining strength capacity

Cause
- GoM following a hurricane
- Final tilt – 8.8deg
- Response suggests 130 to 150te pull from flowline

Recommendation
- Detailed FEA to determine fitness-for-purpose
- Conductor plastic strains ~ 4%

Stress-Strain Curve: Ramberg-Osgood, K=1.13, n=27.13

Tilt Angle of Top of Spool Tree (deg)

Total Strain (Elastic + Plastic)

Conductor (Upper Bound Soil Strength)
Conductor (Lower Bound Soil Strength)
Casing (Upper Bound Soil Strength)
Casing (Lower Bound Soil Strength)
Max Allowable (API RP 2A)

Yield Strain = 0.2%

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Issue 9 – Subsea Components

Issue
• Visual inspections gives little or no information on the health status

Recommendation
• Hydraulic fluid consumption KPI
• Control valve failure prediction
• Subsea communications health
• Electrical insulation health
• HPU pump cycle monitoring

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Assuring ongoing availability of the subsea systems by:

- Practicing and budgeting integrity management as a compulsory activity instead of being reactive to integrity problems considering opportunity cost of shutdowns
- Ensuring competency of the personnel involved in all stages of IM process and in all disciplines
- KPI tracking through integrity monitoring and inspection thus tracking the performance over time and not just a snapshot in time
- 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.