2H offshore

Riser & Conductor Engineering

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

- Introduction
- Consideration of IM in Field Development
- Utilizing Production Monitoring for Condition Assessment
- Technical and System Performance Measures
- Competency of Personnel
- Summary
Subsea component failure is relatively infrequent

- Requiring continuous re-assessment on performance

- In some cases intervention will be required within lifetime

- Failure should be considered with respect to:
  - Compromised Containment
  - Loss of function-ability
  - Lack of control-ability
  - Structural impairment
Subsea development is pushing the boundaries of knowledge.
Inspection Management
Prescribed Inspection Method
Limitations

Inspection alone only does not provide full status on asset health, due to:

- Lack of visibility of failure mechanisms
- Visual constraints due to Marine growth
- Limited visual access due to equipment
- Environmental constraints
- No operational measurements
- Lack of information on damage rate
- No real time warnings
Delivering Underwater Integrity Assurance

- Risers
- Flowlines
- Trees
- PLETS
- Dynamic Umbilicals
- Static Umbilicals
- Flying Leads
- Well jumpers
- Skids
- Subsea structures
- Hulls
- Moorings
- Topsides control equipment
Integrity Services Delivered
Integrity Management Process

Management of risk to personnel safety, asset availability and the environment
Mitigation, Monitoring and Inspection

Criticality

Consider Mitigation → Define Mitigation → Define suitable KPI

Compute maximum inspection period

Is monitoring more effective?

Yes → Define Monitoring → Define suitable KPI

No → Define Inspection Requirements → Define suitable KPI

Revise Criticality
Early Consideration of IM

Subsea IM Activities

- Risk based integrity assessment
- Monitoring requirements/specifications
- Inspection package preparation
- Baseline inspection
- Ongoing integrity management

Timeline:
- Development drilling
- Subsea system design
- Subsea system fabrication
- Subsea system installation
- Field operation
IM Through Asset Life

- Design
- Fabrication
- Installation
- Operations Issues
  - Personnel changes
  - Service changes
  - Reservoir changes
- Accidents
- Events
- Expertise
- Corrosion
- Fatigue
Monitoring within IM

Past
validate performance against design

Present
operational assistance
assure system is within limits
early anomalies identification

Future
historical record
expand complexity understanding
enhanced systems
improved confidence
<table>
<thead>
<tr>
<th>Equipment / System</th>
<th>Tracked Parameter</th>
<th>Indication / Measure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Choke</td>
<td>Choke differential pressure</td>
<td>Choke wear. Abnormal flow through choke indicating imminent failure.</td>
</tr>
<tr>
<td>Subsea Control Module (SCM)</td>
<td>Control circuit blockage</td>
<td>Blockage of LP &amp; HP supply lines.</td>
</tr>
<tr>
<td>Hydraulic Control System</td>
<td>Fluid circuit blockage</td>
<td>Debris build-up in the system. Failure to operate subsea valves.</td>
</tr>
<tr>
<td>Master Control Station (MCS)</td>
<td>Communication properties</td>
<td>Degradation and error rates for communications.</td>
</tr>
<tr>
<td>Surface Controlled Subsurface Safety Valve (SCSSV)</td>
<td>Differential pressure monitoring</td>
<td>Imminent leakage of critical safety equipment.</td>
</tr>
<tr>
<td>Dynamic Umbilical</td>
<td>Fatigue loading</td>
<td>Fatigue limits based on currents, wave height and vessel offset.</td>
</tr>
<tr>
<td>Threat</td>
<td>Tracked Parameter</td>
<td>Remediation</td>
</tr>
<tr>
<td>--------------------------------</td>
<td>------------------------------------------------</td>
<td>------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Overstress of risers</td>
<td>Vessel offset, wave height, wind speed, current velocity</td>
<td>Environmental factors are evaluated to determine whether detailed analysis, inspections, or monitoring is required</td>
</tr>
<tr>
<td>SCR over stress and compression at TDP</td>
<td>Downward porch velocity</td>
<td>Detailed finite element analysis</td>
</tr>
<tr>
<td>Riser over stress</td>
<td>FlexJoint rotation</td>
<td>Indicative of over stress in drilling risers; initiates detailed analysis of the event</td>
</tr>
<tr>
<td>TTR over stress</td>
<td>TTR stroke</td>
<td>Detailed finite element analysis</td>
</tr>
<tr>
<td>FlexJoint performance</td>
<td>Fluid temperature and pressure</td>
<td>Inspection of components; initiate monitoring of rotation and stress relative to</td>
</tr>
<tr>
<td>VIV fatigue damage</td>
<td>Current profile exceedance</td>
<td>Compared against current profiles from riser design; if exceeded, fatigue life is re-evaluated using measured data</td>
</tr>
<tr>
<td>Wave fatigue damage</td>
<td>Vessel roll/pitch exceedance</td>
<td>Compared against vessel motions used during from riser design; if exceeded, fatigue life is re-evaluated using measured data</td>
</tr>
<tr>
<td>TTR tension loss</td>
<td>Tension cylinder pressure</td>
<td>Analysis to determine consequence of tension loss on stress, fatigue</td>
</tr>
</tbody>
</table>
- Prescribed “amber” and “red” limits
- Typically linked to operating and design maxima
- Limits associated with automated response actions
Mudline Conductor Fatigue

- Riser top section with strain gages
- Keel joint lower taper with 2 off motion loggers
- Riser below keel section with VIV loggers
- Lower stress joint with 2 off motion loggers
- Sea bed
- ROV Installable Logger Holder
Mudline Conductor Fatigue

RISER S09 LSJ TOP ACCELERATION RESPONSE

RMS Between 2 and 50 sec

0.000 0.002 0.004 0.006 0.008 0.010 0.012 0.014 0.016

6-Aug-05 16-Aug-05 26-Aug-05 5-Sep-05 15-Sep-05 25-Sep-05 5-Oct-05

Date

Acceleration (m/s²)

X - Accl Y - Accl Acceleration Threshold = 0.0081 m/s²

Hurricane Katrina

Threshold based on 2000 yrs fatigue life

10-12ft NE seas 20-25 knots winds

Hurricane Rita

2000 yrs fatigue life
Riser Bending Moment vs. Hs
Condition monitoring
- Pressures
- Temperatures
- Flow rates
- Sand erosion
- Corrosion coupons
- Fluid sampling

System response monitoring
- Hydraulic reservoir level alarms
- Valve command failure alarms
- Data readback communication outages
- Low hydraulic pressure alerts
- Computer malfunctions

Reviewing system response data for integrity
Example: Choke Health Status Indicator

- System sensors:
  - Flow pressure upstream
  - Flow pressure downstream
  - Indicates production flow rates
- Additional sensor
  - Position indicator
- Combination indicates condition of the choke
Example: Communication Health Indicator

- Subsea coms system does:
  - Parity check
  - Logs event coms error
  - Preset alert failure levels

- Additional algorithm
  - Trend the error data

- Increasing rates indicates incipient coms channel failure
Pre-Determined Rapid Response

- Automated response following the breach of technical performance measure limits
- Emergency planning for significant events
- Confirmation on current condition
- Verification of fit for purpose based on revised criteria
- Maintenance of records relating to system integrity
- Maintenance of analytical models for quick evaluation of the system and associated risks
System Performance Measures

**Leading indicators:**
- Overdue inspections and tests for each equipment class
- Open inspection or test deferrals
- Outstanding actions from reviews and audits
- Outstanding inspection and monitoring reports and records updates

**Lagging indicators:**
- Number of equipment test failures
- Reliability/availability of facility/plant or equipment items
- Number of interventions or notifications by regulatory authorities pertaining to integrity programmes
- Closure of corrective work or actions and anomalies in accordance with agreed time limits
Competency of Personnel

Function & Operation
including failure modes and repair options

IM processes and procedures

Communications
including roles and responsibilities
### Summary - Required Approach

- Implementation of justifiable and auditable risk based IM plans
- Coordinated planning of all IM activities
- Ensuring involvement throughout process with Operations personnel
- Combining reliability and risk
- Risk assessment specifying monitoring, mitigation and inspection needs
- Technical performance measures linked to all monitoring and mitigation
- Regular issue of technical and system performance measures
- Centralised data management
- Delivery of IM data in user friendly manner providing ongoing asset health
- Competence of personnel responsible for IM is essential
Summary - Benefits

- Targeting inspection and monitoring on critical components
- Ability to justify extension to useful life and possible re-use
- Predicting failure and being able to implement cost effective repairs
- Feeding back experience into future design
- Reduced unplanned downtime
- Providing continuous ‘health check’ through continuous surveillance
- Managing information and knowledge in order to make informed decisions
- Determining the rate of deterioration and hence the probability of components to last their required service life at the required performance level
- Reducing overall cost (direct + indirect) by managing risk and improving safety.
Questions?

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Thank you

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