Provision for Long-Term Integrity Assurance

Peter Falconer

June 2011
Agenda

- Introduction
- Consideration of IM in Field Development
- Utilizing Production Monitoring for Condition Assessment
- Technical and System Performance Measures
- Competency of Personnel
- The Way Forward
- Summary
Common Issues

- IM often seen as an activity undertaken during operations only
- Subsea IM restricted to pipelines and structures
- Failure assessed for breach of containment only
- Reliability not considered along with Risk
- IM is viewed as a one off review or with large periods between update
- IM is considered as determining inspection requirements only
- System monitoring information not utilised for condition monitoring
- Lack of understanding for IM requirements within operations teams
- Integrity information held in numerous disparate locations
- Temptation to use sub-standard materials to deliver on time, leading to additional “cost” during operations
- Insufficient knowledge and experience of those responsible for subsea IM, e.g. risks, reliability, inspection/monitoring technology, repair options, etc.
Why IM?

Subsea component failure is relatively infrequent

Technology Advance

Aging Facilities

Environmental Uncertainties

Economic Pressures

US Light Sweet Crude Prices - 2009

$ per barrel
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
Integrity Management

Management of risk to personnel safety, asset availability and the environment through continuous assessment.
Definition of Mitigation, Monitoring and Inspection

Criticality

<table>
<thead>
<tr>
<th>Probability</th>
<th>Impact</th>
<th>Risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Medium</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>High</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Very High</td>
<td>4</td>
<td>4</td>
</tr>
</tbody>
</table>

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
Early Consideration of IM

Development drilling

Subsea system design → Subsea system fabrication

Subsea system installation

Field operation

Subsea IM Activities

Risk based integrity assessment

Monitoring requirements/specifications

Inspection package preparation

Baseline inspection

Ongoing integrity management
Early Consideration of IM

- Implications of IM assurance considered during design stages
- All failure (Risk and Reliability) mechanisms reviewed
- Cost of operating determined based on both CAPEX and OPEX through asset life
- Design options investigated
Monitoring

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
# Examples – Subsea Technical Monitoring

<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>
</tbody>
</table>
Retrofit Monitoring

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

**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
Performance Measures

Simple traffic light system required for periodic reporting to management

Technical Performance
- Identifying potential compromised integrity, due to breach of measures established as a result of risk assessment

System Performance
- Indicating that the systems and processes are not effective or not being followed
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
Competency of Personnel

Function & Operation
including failure modes and repair options

IM processes and procedures

Communications
including roles and responsibilities
The Way Forward

- Subsea, and particularly deepwater, image has been tarnished

- Salazar - ‘The oil and gas industry will be operating under tighter rules, stronger oversight, and in a regulatory environment that will remain dynamic’

- It is inevitable that greater emphasis will be placed on subsea IM with increased scrutiny and increased equipment qualification required

- There may be a need to review what is currently in place and determine whether it is both effective and complete

- All aspects of IM should be extended into all phases of the field life

- Resulting in greater emphasis to IM during design
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
- Risk/ reliability assessment specifying monitoring, mitigation and inspection needs
- Regular issue of performance measures linked to all monitoring and mitigation
- Centralised data management
- Delivery of IM data in user friendly manner providing ongoing asset health
Summary - Benefits

- Asset risk profile at a glance
- Supports rapid strategic decision making
- Management aware of action and inaction impact
- Priority given to review of critical components
- Ability to justify extension to useful life and possible re-use
- Feeding back experience into future design
- Reduced unplanned downtime
- Predicting failure through rate of deterioration
- Reducing overall cost (direct + indirect) by managing risk and improving safety.
Questions?

Contact Information:

Peter Falconer
2H Offshore
peter.falconer@2hoffshore.com
Tel (D) +44 (0)1224 452 380
Tel (M) +44 (0)7825 698 941