An Integrated Matrix of Assurance Services to Ensure Well Integrity in New and Ageing Infrastructure

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Agenda

- Who should be interested and why
  - The integrity issue
  - An approach to solve the issue
Who should be interested – and why!

The obvious candidates:
- Constructors of wells
- Operators of wells
- Regulators of wells

And also:
- Sellers of wells
- Buyers of wells
- Insurers of wells
- Financiers of wells

- **Anybody who is interested in maximising and protecting reputation and value in their upstream business**

- Also : No wells => redundant infrastructure
  Infrastructure integrity loss => wells are useless!
Well integrity risks can have enormous magnitude and consequence but low probability

Typically high consequence-low probability risks are difficult to quantify

Well Integrity Assurance is a way to reduce the risk of unplanned events.

A robust method of preventing massive loss of well integrity is critical to the future of the UKCS, especially in frontier technical or geographical areas.

- Current legislation
- Improved and systematic practises
So….

• the risk for the UKCS is also with the smaller more likely (or even inevitable) integrity issues which require to be and can be managed

• Minor integrity failures will have an amplified affect on our business

• Keep on top of well integrity or lose your business control ….The Well Integrity Vortex©
• Well integrity slips
• Not economic to repair
• Production declines
• Reserves lost

.....a downward spiral
Well Integrity Vortex ©

Well Maintenance Falls Behind → Loss of Well Integrity

Weak well integrity system

New Fields Sub-Economic → Revenue or Reserves Lost for Operator

Infrastructure Abandoned

Intervention to Repair More Complex

Opex Share Increases for Other Wells → Reserves Deferred & Lost

Opex Share Increases for the tied in fields

Well Shut-In → Unable to Justify Repair Cost

Reserves Lost for Nation

Reserves Lost for Nation
Loss of Integrity

- Macondo – 2010
  - Massive cost ……still evolving
- Piper Alpha – 1988
  - New platform
  - Claymore and Tartan shut in for over a year
  - $3.4 billion of insured claims – how much more was lost?

- Non UK gas platform
  - Shut down for extended period. >$1billion business interruption insurance claim
- Njord – April 2011
  - Shut down due to gas leak in riser
  - 70,000 boe/day deferred ($60million / week)
The Matrix Approach

• Map the full life cycle of the well
  • Design through production to abandonment

• Map the integrity requirements for:
  • People
  • Equipment
  • Procedures

• Identify each ‘brick’ or element which is required to maintain a competent wall
The Matrix Approach

- Construct the Integrity ‘Wall’ to identify all risks
- **Add the tools which allow manageable risks through**
- Each element has an owner, procedure, supplier, etc
<table>
<thead>
<tr>
<th>VALUE</th>
<th>Well Life Cycle</th>
<th>INTEGRITY</th>
</tr>
</thead>
</table>
| Development cost | 1. Design | • Competent engineers  
| | 2. Construct  
| | 3. Commission  
| | 4. Operate  
| | 5. Maintain  
| | 6. Modify  
| | 7. Suspend  
| | 8. Abandon  
| Manage value | 1. Design | • Operating parameter targets and limits  
| | 2. Construct  
| | 3. Commission  
| | 4. Operate  
| | 5. Maintain  
| | 6. Modify  
| | 7. Suspend  
| | 8. Abandon  
| Defer expenditure | 1. Design | • Constraints  
| | 2. Construct  
| | 3. Commission  
| | 4. Operate  
| | 5. Maintain  
| | 6. Modify  
| | 7. Suspend  
| | 8. Abandon  
| | • Operating procedures & responsibilities  
| | • Testing & reporting  
| | • Spares & repairs  
| | • Robust engineering abandonment plans  
| | INTEGRITY | • Realistic suspension methodology and durations  
| | • Suspended well monitoring  
| | • Robust engineering abandonment plans  
| | 8. Abandon |
### Well Integrity Elements that Everybody Needs to Have

#### Top Level Well Integrity Matrix

<table>
<thead>
<tr>
<th>Well Life Cycle</th>
<th>A. EQUIPMENT</th>
<th>B. PROCESSES &amp; PROCEDURES</th>
<th>C. PEOPLE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Design</td>
<td>Equipment and material standards applicable to well types, fluid types, service type and duration.</td>
<td>Design Verification/Examination Peer assist, Peer review Contingency &amp; relief well planning Certification and inspection requirements</td>
<td>Well engineering competence assessment Subsurface engagement and competence</td>
</tr>
<tr>
<td>3. Commission</td>
<td>Performance standards set and verified for installed equipment.</td>
<td>Handover process Operating parameter review process</td>
<td>Multidisciplinary skills Drilling &amp; Production mutual understanding</td>
</tr>
<tr>
<td>4. Operate</td>
<td>Data gathering, monitoring and control systems functionality</td>
<td>Systems for operating within set parameters and responding to avoid deviations. Monitoring, testing &amp; reporting process</td>
<td>Operator competence assessment</td>
</tr>
<tr>
<td>5. Maintain</td>
<td>Availability of appropriate spare parts. Condition monitoring capability</td>
<td>Maintenance process Management of priorities and backlog Management of degraded SCEs</td>
<td>Well equipment competence assessment</td>
</tr>
<tr>
<td>6. Modify</td>
<td>Continued suitability of equipment within new operating environment according to standards of the day</td>
<td>Management of change process Linked well design and production process</td>
<td>Awareness of and adherence to change processes</td>
</tr>
<tr>
<td>7. Suspend</td>
<td>Effective life span of suspension tools and equipment</td>
<td>Process to verify, monitor and periodically reassess. Establish forward plan for suspended wells</td>
<td>Well engineering competence assessment Subsurface engagement and competence</td>
</tr>
<tr>
<td>8. Abandon</td>
<td>Minimum standards according to reservoir and well type</td>
<td>Design Verification/Examination Application of standards</td>
<td>Well engineering competence assessment</td>
</tr>
</tbody>
</table>
Well Integrity Elements that Everybody Needs to Have

**Equipment**
- Procurement
- Changes in purpose throughout the well’s life
- Degradation

**Procedures, Policies & Standards**
- Broad range of activities & disciplines
- Handover procedures & knowledge

**People**
- Available resources with correct skills
- Change in ownership through well’s life
- Maintaining sufficient competence
Integrity Assurance Models

**Well Life Cycle**

1. **Design**
   - DESIGN VERIFICATION
     - Review design for well or well campaign

2. **Construct**
   - PROGRAMME VERIFICATION
     - Review programme for a well or campaign and ensure it reflects design
   - CONSTRUCTION VERIFICATION
     - Monitor drilling operations and verify integrity elements of design

3. **Commission**
   - WELL STATUS VERIFICATION
     - Review well stock for failures, risks, dispensations, outstanding work

4. **Operate**
   - INTERVENTION VERIFICATION
     - Review programme for intervention work

5. **Maintain**

6. **Modify**

7. **Suspend**

8. **Abandon**
   - ABANDONMENT DESIGN VERIFICATION
     - Review design and programme for well abandonment

**Design Capability**
- Assessment of organisational ability to deliver robust well designs

**Well Construction Capability**
- Assessment of organisational ability to deliver quality operations (including decommissioning)

**Maintenance Capability**
- Assessment of organisational ability to identify and carry out effective maintenance

**Intervention Capability**
- Assessment of organisational ability to deliver quality interventions
“My integrity is important to me so I can sell it to the highest bidder” – Newspaper cartoon!

- Reduces safety risk
- Reduces environmental risk
- Reduces reputational risk
- Reduces production deferment risk
- Increases predictability
- Maintains production longer
- Extends viable life for key infrastructure
- Reduces cost
- Reduces purchase risk
- Maximises selling revenue
- **It's good for business**

“Churn” is critical to the longevity of the UKCS, and systematic integrity assurance facilitates churn.
How and When?

• The matrix approach suggested is not difficult to generate or apply, but needs:
  • management commitment
  • systematic thinking
  • a base of standards and procedures
  • a competent, controlled, systematic and pragmatic approach to dispensation and risk assessment
  • focused application

• And it needs it now!

• Questions?