Agenda

- What are the main drivers and effects of ageing?
- What is ageing and what factors are usually considered?
- What other factors need to be considered?
- What are some typical findings from asset life extension studies?
Main drivers

- Possible reuse for CO2/gas storage
- Advances in technology
- Delayed decommissioning

- Marginal fields financially viable
- Increasing use of subsea tiebacks
- Change in use of platforms to hubs

Source – Oil & Gas UK, 2010 Economic Report
### Effects

#### Age profile of offshore installations

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>SHELL</td>
<td>14</td>
<td>4</td>
<td>3</td>
<td>15</td>
<td>10</td>
<td></td>
<td>46</td>
</tr>
<tr>
<td>PERENCO</td>
<td>19</td>
<td>9</td>
<td>4</td>
<td>12</td>
<td></td>
<td></td>
<td>44</td>
</tr>
<tr>
<td>CONOCOPHILLIPS</td>
<td>12</td>
<td>11</td>
<td>9</td>
<td>9</td>
<td></td>
<td></td>
<td>41</td>
</tr>
<tr>
<td>BP</td>
<td>5</td>
<td>7</td>
<td>21</td>
<td>3</td>
<td></td>
<td></td>
<td>36</td>
</tr>
<tr>
<td>TALISMAN</td>
<td>5</td>
<td>5</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td>13</td>
</tr>
<tr>
<td>CENTRICA</td>
<td>5</td>
<td>4</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td>12</td>
</tr>
<tr>
<td>TULLOW</td>
<td>6</td>
<td>2</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td>9</td>
</tr>
<tr>
<td>CENTRICA - HRL</td>
<td>7</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>8</td>
</tr>
<tr>
<td>BHP</td>
<td>7</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>7</td>
</tr>
<tr>
<td>CNR</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td>7</td>
</tr>
<tr>
<td>APACHE</td>
<td>6</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>6</td>
</tr>
<tr>
<td>NEXEN</td>
<td>2</td>
<td>4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>6</td>
</tr>
<tr>
<td>TOTAL</td>
<td>2</td>
<td>1</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td>6</td>
</tr>
<tr>
<td>CHEVRON</td>
<td>5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>5</td>
</tr>
<tr>
<td>ITHACA</td>
<td>4</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>5</td>
</tr>
<tr>
<td>BG</td>
<td>4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>4</td>
</tr>
<tr>
<td>TAQA</td>
<td>1</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>4</td>
</tr>
<tr>
<td>ATP</td>
<td></td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>ENQUEST</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>EXXONMOBIL</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>MAERSK</td>
<td>2</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>MARATHON</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>BOL</td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>RWE DEA</td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>EON RUHRGAS</td>
<td></td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>ERT</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>FAIRFIELD</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>GAZ DE FRANCE</td>
<td></td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>PETROCANADA</td>
<td></td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>TOTAL</td>
<td>44</td>
<td>46</td>
<td>56</td>
<td>94</td>
<td>42</td>
<td>1</td>
<td>283</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Year</th>
<th>1960s</th>
<th>1970s</th>
<th>1980s</th>
<th>1990s</th>
<th>2000s</th>
<th>2010s</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manned</td>
<td>14%</td>
<td>16%</td>
<td>20%</td>
<td>33%</td>
<td>15%</td>
<td>0%</td>
</tr>
<tr>
<td>Unmanned</td>
<td>16%</td>
<td>16%</td>
<td>20%</td>
<td>33%</td>
<td>15%</td>
<td>0%</td>
</tr>
</tbody>
</table>

© ABB Group  
July 10, 2014 | Slide 4

Source - DECC
Effects

Hydrocarbon releases

Effects
Health & safety

- 173 loss of containments in RIDDOR attributable to ageing (1996 – 2008)
- Represents 5.5% of all loss of containment events
- Limited information on underlying cause in RIDDOR means number could be much higher

- Across Europe 96 incidents reported in the MARS database relating to loss of containment due to ageing (1980 – 2006)
- Represents 28% of all reported loss of containment events
- Equates to an overall loss of 11 lives, 183 injuries and > Euro 170m of loss

Source – HSE Research Report 823 – Plant Ageing Study – Phase 1 Report
Effects
Financial - Reliability

Reliability at Risk

Extended Emergency Shutdowns to Replace Major failed Equipment
General Unreliability
What is ageing?

“Ageing is not about how old the equipment is. It’s about what is known about its condition, and how that’s changing over time”


Managing equipment life starts here!

Starting at this stage is more difficult!
What is ageing?

Causes of equipment failure

It’s only 10-15%, but they’ll still shut down the installation!
What is ageing?

Corrosion

Source - Photographs from HSE Corrosion Project Presentation by Andrew Duncan, Specialist Inspector
What is ageing? Obsolescence

Mainly affects:
- Electrical equipment
- Instrumentation
- Control systems and software
- Telecommunications
- Rotating equipment

In practice, some equipment can continue to be maintained in the Obsolete phase – although plant downtime may be increased.
What is ageing?
Influences & solutions for obsolescence

- Onset of obsolescence is influenced by:
  - Technological developments - e.g. solid-state electronic devices replacing electro-mechanical protection relays
  - Commercial factors - e.g. supplier closing down, taken over, etc.
  - Loss of service engineers’ expertise due to retirements & new technologies

- Obsolescence can be addressed by:
  - Replace all obsolete items with current products
  - Partial replacement, with the removed items held as spares
  - Adopting a ‘run-to-failure’ policy with current products as spares
  - Special manufacture of key spare parts
What other factors need to be considered?
Changing production profiles & fluid composition

- Higher levels of CO$_2$ / H$_2$S
- Multiphase flow when equipment is designed for single phase flow & vice versa
- Compressor and pump limitations
- Increased solid content
- Increased water injection, gas lift, etc.
- Increased power demands
- Less fuel gas for power generation
What other factors need to be considered?

Changing regulation

- HSE KP3 & 4 Programme - asset integrity is a priority for the HSE Offshore Division
- Safety Case - Technical justification for extended operation and redundant / additional equipment
- ATEX & PFEER mean like for like replacement of old equipment may no longer be possible
- Replacement of R22 in HVAC refrigeration systems
- CO and NOX emission requirements for gas turbine installations
- Renewable Energy Directive - increasing use of bio-fuels
What other factors need to be considered?
Age & competency of workforce

- Loss of highly experienced personnel
- Succession planning & knowledge retention
- Different competencies & working methods
- Changing training & development requirements
- Application of new technologies
- Less people and multi-skilled
What other factors need to be considered?

Dependence upon 3rd parties

- Increasing trend
- Leaner organisations
- On-going operation increasingly dependent upon sharing of information with and between 3rd parties
- Competency assessment, inductions & debriefing are critical
- Agreement on ownership of knowledge, records & maintenance histories even beyond contract duration
What other factors need to be considered?

Design and operational data

- Retaining corporate knowledge for the extended life cycle
- 30 year old information and data needs to be kept for a further 30 + years
- Moving to software based document management systems
- Loss of data when systems are changed or when assets change ownership
- No longer able to read electronic data in old formats
- Old versions of documents and drawings
What other factors need to be considered?
Management systems

- Policy and leadership
- Adequate resources
- Defined roles and responsibilities
- Strategy considerations
- Planning and budgeting
- Interlinked and reviewed KPIs

Source - HSG65 - Successful Health & Safety Management
ABB Asset Life Extension Assessment Process

1. Review History
2. Collect Data
3. Identify Recommendations & Associated Costs
4. Assess Future Life
5. Develop Cost Summary

Pressure Systems
Rotating Equipment
Structures
Control & Instrumentation
Electrical Systems
Safety Systems
Asset Life Extension Study

Key deliverables

- Overview Of Deterioration Modes & Status
- Life Limiting Issues & Risks
- Asset Life Cycle Actions & Costs
- Asset Life-Time Expenditure Profiles
Asset Life Extension Study typical physical findings
Pressure systems

- Focus on hydrocarbon containing systems
- Internal and external corrosion of utility systems is common and understated
- Significant corrosion and erosion in seawater systems
- Bolting and gasket deterioration is common
- Limited maintenance on non-return valves
- Reduced life of internal protective coatings
- Need for fatigue life calculations, e.g. instrument air pressure swing absorbers
- Deteriorating redundant equipment
- Thermal degradation of flare lines close to tip and tip itself not always considered
Asset Life Extension Study typical findings

Rotating equipment

- Compressors and pumps turn-down capability - inadequate for predicted production profile
- Seawater lift & fire pumps are inaccessible and extent of maintenance varies widely
- Structural vibrations associated with replacement diesel generators a major contributor to unreliability
- Alternators are inherently unreliable and ownership is not always clear
- HVAC system maintenance variations
- Limited spares held offshore
Asset Life Extension Study typical findings

Electrical & control

- Neglected cathodic protection systems
- Protection reconfiguration & obsolescence
- Power supply reliability and capacity
- Cables and cable tray supports neglected
- UPS systems not well maintained
- DCS typically have a service life of 15-20yrs
- Process alarms often added without thought for overall alarm management
- Local control panels and mechanical limit switches for valves can be problematic in exposed locations due to corrosion
- Redundant equipment not always isolated
Asset Life Extension Study typical findings

Structural & safety

- Process required for inspection, repair and replacement of weather and fire doors
- Strategy to replace minor steelwork (handrails and ladders)
- Replacement of caissons (plus ownership)
- Obsolete fire and gas detectors - barrier limitations
- Obsolete communication equipment and UPS power supplies
Summary

- “Find & Fix” Culture to “Predict & Prevent ” Culture
- Proactive approach rather than fire fighting
- Utilise previous operational knowledge to help plan for the future
- “No surprises” - integrity, health & safety, environmental, commercial

- “Ageing is not about how old the equipment is. It’s about what is known about its condition, how that’s changing over time and how effectively you are managing the associated risks”
Power and productivity
for a better world™