Session 1

• Product reliability and requirements
  – Key standards & documents
  – Key reliability parameters and how Statoil makes use of these
  – Redundancy*
  – Electronics and IPC
  – Qualification & Robustness testing
• Statoil’s experiences with subsea equipment and failure rate, and lessons learned*
• Q & A session
Main functions

Secure PSD (Process Shut Down) & ESD (Emergency Shut Down) to bring equipment / facility in safe state

Steering, control and monitoring of sensors, actuated valves and downhole equipment
Main Components

• HPU
• Subsea Control Unit (SCU or MCS)
• Subsea Power & Communication Unit
• Operator stations
• Test Panels
• Umbilical
• Communication Distribution & Subsea Control Moduls
• Sensors
Subsea Control System  
- Product / Component Reliability

Reliability = The probability that an item will perform a required function without failure under stated conditions for a stated period of time

- Vital to ensure subsea control system operation within specified parameters
- Vital securing PSD & ESD to bring facility in safe state
- Vital to ensure system availability

Vital for safe oil & gas production!!!
### International Standards

<table>
<thead>
<tr>
<th>Standard</th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td>API 17F</td>
<td>Standard for Subsea Production Control Systems</td>
</tr>
<tr>
<td>ISO/TR 10949</td>
<td>Hydraulic fluid – Component cleanliness – Guidelines for achieving and</td>
</tr>
<tr>
<td></td>
<td>controlling cleanliness of components from manufacture to installation.</td>
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<tr>
<td>ISO 4021</td>
<td>Hydraulic fluid power – Particulate contamination analysis</td>
</tr>
<tr>
<td>ISO 4405</td>
<td>Hydraulic fluid power - Fluid Contamination – Determination of particulate</td>
</tr>
<tr>
<td></td>
<td>contamination by the gravimetric method</td>
</tr>
<tr>
<td>ISO 12103-1</td>
<td>Road Vehicles – Test Dust for Filter Evaluation</td>
</tr>
<tr>
<td>ISO 18413</td>
<td>Hydraulic fluid power – Cleanliness of parts and components</td>
</tr>
<tr>
<td>ISO 23309</td>
<td>Hydraulic fluid power systems – Assembled systems – Methods of cleaning</td>
</tr>
<tr>
<td></td>
<td>lines by flushing</td>
</tr>
<tr>
<td>ISO 90003</td>
<td>Guidelines for the application of ISO 9001:2000 to computer software</td>
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</tbody>
</table>

### Statoil Technical Requirements

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td>TR 1233</td>
<td>Subsea Production Control Systems</td>
</tr>
<tr>
<td>TR 3037</td>
<td>Automation systems integration of subsea production control</td>
</tr>
</tbody>
</table>
## Product / Component Reliability
### Key requirements  (Technical, Subsea Control System related)

<table>
<thead>
<tr>
<th>Joint Requirements</th>
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</thead>
<tbody>
<tr>
<td><strong>SAE AS 4059</strong></td>
</tr>
<tr>
<td><strong>IPC-A-610</strong></td>
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<tr>
<td><strong>IPC-7711/7721</strong></td>
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<tr>
<td><strong>J-STD-001</strong></td>
</tr>
<tr>
<td><strong>SIIS STD-01</strong></td>
</tr>
<tr>
<td><strong>SIIS RP</strong></td>
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<tr>
<td><strong>IWIS RP</strong></td>
</tr>
<tr>
<td><strong>SEAFOM TSD-02</strong></td>
</tr>
<tr>
<td><strong>3428A rev1.5</strong></td>
</tr>
</tbody>
</table>
Product / Component Reliability Parameters

Measurable
- System availability
- Failure rates
- Retrieval frequency

«Soft»
- Evolution of governing and operational requirements
- Technology evolution
- General Operational experience
- Dialogue with suppliers
Product / Component Reliability
Example “Technology Evolution” – DC/FO

Background:
• Current systems have limitations -> power and distance
• DCFO: new cabled system based on telecom standards
• Alcatel Lucent Submarine Networks (ASN) industrial partner
Highly Accelerated Life Testing (HALT)

- Stress testing methodology for products and solutions aiming to provoke failures commonly seen after long-term use within a relatively short period of time.
- Results can be used to modify the solution so that the product’s lifetime is increased.
- HALT is first and foremost a method that helps in the development of reliable products with a long lifetime.
- It is not a method for predicting how long lifetime a product will have.
Product / Component Reliability
Qualification & testing – HALT

Prior to HALT

After HALT
There is no **one** right way to run HALT.

One way is to start using single environments, then running with combined environments for comparison using various samples.

**Typical tests are:**

- cold step test
- hot step test
- rapid temperature cycling test
- stepped vibration (random) test
- combined environment stress
TR 1233: Highly Accelerated Lifetime Testing (HALT) should be used to ensure quality of PCBs.
Product / Component Reliability
Electronics Assembly

IPC-A-610 - Acceptability of Electronic Assemblies
• Widely used acceptability standard for electronic assemblies
• Collection of visual quality acceptability requirements
• Also covers Electrostatic discharge (ESD).

IPC J-STD-001D - Requirements for Soldered Electrical and Electronic Assemblies
• Contains comprehensive, critical details about
  - Processes
  - Materials
  - Testing methods for soldered assemblies.
IPC-A-610 and J-STD-001 have three product classes

• CLASS 1 - General Electronic Products
• CLASS 2 – Dedicated Service Electronic Products:
  – Includes products where
    • Continued performance and extended life is required, and for which uninterrupted service is desired but not critical.
    • Typically the end-use environment would not cause failures.
• CLASS 3 – High Performance Electronics Products:
  – Includes products where
    • Continued high performance or performance-on-demand is critical
    • Equipment downtime cannot be tolerated
    • End-use environment may be uncommonly harsh, and the equipment must function when required.
• Statoil require CLASS 3
Session 2

- Sub-supplier quality assurance
- Component obsolescence
- Q & A session
Sub-supplier quality assurance

- “Mundighetskrav”, Industry standards, Statoil requirements & expectations
- Statoil process landscape (e.g. from technology development (FR12) to project execution (FR05))
- Project contracting strategy & associated risk picture
- Complexity of supply chain (e.g. sub-supplier level)
- Experience & trust
Component obsolescence

- Obsolescence is a particular issue in subsea production systems due to
  - Long lifecycle of these (25 years or more)
  - Difficulty and cost associated with accessing them to undertake repairs or upgrades.
- Obsolescence cannot be avoided, however, it can and should be managed to mitigate for and control its negative impact.
## Component obsolescence

Typical criticality overview in Subsea Production Control System

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Core Component</th>
<th>Technology Evolution</th>
<th>Replacement Alternatives</th>
<th>Obsolescence (Risk)</th>
</tr>
</thead>
<tbody>
<tr>
<td>HPU</td>
<td>Electrical</td>
<td>Moderate</td>
<td>Less difficult</td>
<td>Low</td>
</tr>
<tr>
<td>EPU</td>
<td>Electrical</td>
<td>Moderate</td>
<td>Less difficult</td>
<td>Low</td>
</tr>
<tr>
<td>Umbilical &amp; UTA</td>
<td>Mechanical</td>
<td>Low</td>
<td>Less difficult</td>
<td>Low</td>
</tr>
<tr>
<td>Electrical/hydraulic flying lead</td>
<td>Mechanical</td>
<td>Low</td>
<td>Less difficult</td>
<td>Low</td>
</tr>
<tr>
<td>Subsea Booster pump</td>
<td>Mechanical</td>
<td>Moderate</td>
<td>Difficult</td>
<td>Moderate</td>
</tr>
<tr>
<td>Subsea separator</td>
<td>Mechanical</td>
<td>Moderate</td>
<td>Difficult</td>
<td>Moderate</td>
</tr>
<tr>
<td>Software</td>
<td>Programme</td>
<td>High</td>
<td>Less difficult</td>
<td>Moderate</td>
</tr>
<tr>
<td>SCM</td>
<td>Electronics</td>
<td>High</td>
<td>Very difficult</td>
<td>Very high</td>
</tr>
</tbody>
</table>
Component obsolescence
Typical cost resolution (Tordis)

- Reactive Obsolescence cost
  = US$478 M

- Proactive Obsolescence cost
  = US$26.2 M

- Loss production following a reactive resolution strategy can imply high OPEX.

Source: Cranfield University
Component obsolescence

http://www.subseaobs.com/

• Joint operator approach resulting in «Subsea Obsolescence Management - Joint Operator Specification 3428A v1.5»

• Supplement to IEC 62402 «Obsolescence management»

Obsolescence management = Co-ordinated activities to direct and control an organization with respect to obsolescence.

• Purpose of joint Operator effort is to define a pro-active Obsolescence Management Process (Preventing, Predicting, Resolving)
Component obsolescence
http://www.subseaobs.com/

• Pro-active Obsolescence Management Process

<table>
<thead>
<tr>
<th>Plan for obsolescence</th>
<th>Design for obsolescence</th>
<th>Check for obsolescence</th>
<th>Act as planned</th>
</tr>
</thead>
<tbody>
<tr>
<td>Develop obsolescence management plan in the framework of product life cycle management</td>
<td>Implement pro-active measures as early as possible, preferably in the design phase</td>
<td>Check for obsolescence to ensure early reaction</td>
<td>Consult the plan and apply an appropriate reactive option to handle occurred obsolescence</td>
</tr>
</tbody>
</table>
Component obsolescence
http://www.subseaobs.com/

- Pro-active Obsolescence Management Process in life cycle context
Component obsolescence
http://www.subseaobs.com/

• Minimum requirements:
  – Obsolescence Management Plan
  – Communication Plan
  – Product Life Cycle Diagram
  – Obsolescence strategies - Availability of Obsolescence Information
  – Obsolescence mapping and monitoring - Management of Obsolescence Prediction
  – Obsolescence strategies - Management of Obsolescence Resolution
    • Sourcing (e.g. last time buy)
    • Re-design
There’s never been a better time for good ideas

Subsea Control System Quality & Reliability Assurance

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