Condition Monitoring of ‘Ageing’ Subsea Control Systems

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Subsea Control System

- **Topsides Equipment**
  - Master Control Station (MCS)
  - Electrical Power Unit (EPU)
  - Hydraulic Power Unit (HPU)
  - Topsides Umbilical Termination Unit (TUTU)
- **Subsea Equipment**
  - Umbilical (Hydraulics, Electrics & Chemicals)
  - Umbilical Termination Assembly (UTA)
  - Subsea Distribution Unit (SDU)
  - Electro-Hydraulic Jumpers
  - Subsea Control Modules (SCMs)
  - Instruments (Pressure, Temperature, Position)
  - Xmas Tree Valves & Manifold Valves
Subsea Control System

- EPU
- MCS
- HPU
- TUTU
- UTA
- SDU
  - SCM
  - SCM
- SCM
- SCM
- PT
- TT
- ZT
- XV
So what goes wrong?

- Hydraulic Leaks
  - Major Leaks
  - Weeps & Seeps
- Insulation Resistance (IR)
  - Sudden Loss
  - Gradual Degradation
Hydraulic Leaks

- Major Leaks
  - Hose Rupture
  - Directional Control Valve (DCV) Temporary Misalignment (Interflow)
  - DCV Failure
- Weeps & Seeps
  - Hose Fittings become loose
  - DCV wear
  - Valve Seal wear
Monitoring for Hydraulic Leaks

- Major Leaks are easy to identify
  - Sudden Pressure Loss
  - Increased Usage of Fluid (HPU Tank Level or Flow)
- Weeps & Seeps are far less obvious and need much greater scrutiny
  - Long term data capture to allow analysis & trending
  - Comparison against other similar subsea data points
Monitoring for Hydraulic Leaks
Monitoring for Hydraulic Leaks
Insulation Resistance

- What is Insulation Resistance
Insulation Resistance

- How do we measure it
Insulation Resistance

- Sudden Loss
  - EPU trip (over-current)
  - Total attenuation of comms
- Gradual Degradation
  - Continuously reducing IR
  - Intermittent Line Insulation Monitor (LIM) trips
  - Intermittent comms error / losses
Monitoring of IR

- LIM Readings
  - IR is a constantly changing value
  - Long term data capture to allow analysis & trending
  - How often to log?
  - Differences in trace obtained from different log periods
  - Cyclic nature of reading
  - How long until it fails?
What else should we be monitoring?

- HPU Fluid Cleanliness
- HPU Pump run / stop cycle
- HPU Pressure Control
- EPU Voltage
- EPU Current
- EPU Power Factor
- Umbilical Capacitance
- MCS Modem Errors
- SCM Comms Errors
- All SCM Housekeeping Data
- All important process data
Case Study

- Triton – Electrical Integrity
  - Initial Degradation
  - Increased Instability
  - Ultimate Failure
January 2009
April 2009
June 2009
Oct 2010
RAG Analysis by Month (2009)

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IR Analysis

- Art
- Science
- Engineering Experience
- Actually a bit of all 3
Benefits of Integrity Monitoring

- Monthly Report - £2500 per system per asset (£60k p/a)
- Electrical Jumper ~ £5k
- Electrical Jumper Lead time  12~16 weeks
- DSV Lead time  2~?? weeks
- Planned DSV Repair Cost  £400k
- Unplanned DSV Cost  £700k+
- Lost Production Revenue  £300k - £??MM
- Proactive rather than Reactive
Subsea Controls Integrity Monitoring

- Thank you for listening

- Any Questions?