All Electric Subsea Production System
– A World First

Rory MacKenzie
Total E&P, Technology Division

Key Contributors:
Cedric Roux – Total E&P Netherlands BV, K5-F3 Project Manager
Antonin Baume – Total E&P, Drilling and Wells Division
Ewan Allstaff – Total E&P, Drilling and Wells Division
Juliano Pimentel – Total E&P, Deep Offshore R&D Division
K5F All Electric Xtree

CameronDC Subsea Production System

1. Electric Subsea Control Modules
2. Electrically Actuated Chemical Injection Valves
3. Electrically Actuated Subsea Retrievable Choke
4. Electrically Actuated Production Valves
5. Electrically Actuated Annulus Valves

Electric Power Regulation and Communication Modules

Not shown, mounted on template manifold
K5-F Status Overview

- Development launched in 2005
- AET manufacture and test completed 2008
- **Phase 1** deployed in May 2008
  - Hydraulic SCSSV
  - Actuator reliability – 100% to date
  - Power distribution/Hydraulic system failures experienced
- **Phase 2** development launched in Nov. 2013
  - Business driven decision to include electrical SCSSV to address hydraulic leak issues July 2014
  - Qualified improved system design 2015
  - Completed manufacture and test Jan 2016
  - Deployment due May 2016
Halliburton electrical SCSSV (eDHSV)

Based on Depthstar™ technology

- Field proven (in operation since 2006) – no operational issues
- Magnetically coupled SCSSV – tubing integrity maintained
- 100 % MTM – no moving seals within the tubing wellbore
- eDHSV Fully Qualified to ISO/API and extended HALT/ALT testing

Features

- Dual electric linear actuators
- Electronics isolated from well fluids and pressure
- Position sensor – real time status
- Full redundancy in actuation and controls
Incorporating the eSCSSV into K5F-3

- Hydraulic SCSSV included as backup (project acceptance)
- 2 retrievable A&B channel control units fitted to Xtree
  - Industry standard interface to SCM (low power IWIS)
  - Contains interface cards, PSU and ESD power storage
- 2 additional electrical feedthroughs/cables included
  - Standard downhole gauge components
- Completion design modified to accept electrical SCSSV
- Project specific lock-out tool developed
AE System – Key Benefits

HSE
- Removal of hydraulic fluid
  - Supply, transportation, storage
  - Spillage, contamination
- Removal of high pressure storage

CAPEX
- Removal of topside hydraulic infrastructure
- Removal of hydraulic lines in umbilicals (>> long stepouts)
- Removal of subsea hydraulic distribution system
- Removal of hydraulic tubing on Xtree’s and Manifolds (<-20%)
  (cutting, bending, welding, fitting, flushing, testing etc)

Functionality
- Control, Speed, Feedback, Condition Monitoring, Self Test
- Hybrid options – eDHSV and/or eChoke on conventional EH systems
- Ultra deep water, ultra long offset, subsea processing

Reliability
- Technology transfer - quantifiable MTBF figures, 15 years subsea
- Built-in redundancy all the way to the valve
Case Study – AE/EH long offset Umbilicals

6 well template, 10 valves/well
30 years operation, 3 act/valve/year

Umbilical - 4 x ¾” lines, 2 x FO tubes, 2 x quads/triads

Hydraulic fluid and electrical power consumption (100Mw GTG)

50%-65% cost saving for AE
Conclusion - Long Offset concept (OIL)
Conclusion - Long Offset concept (Gas)