SESSION 4 DEVELOPMENT

PAUL CULPIN
DEVELOPMENT MANAGER

OVERVIEW
CONCEPT FIELD DEVELOPMENT
BASE CASE DEVELOPMENT
LOGISTICS AND INFRASTRUCTURE
PROJECT SCHEDULE
SEA LION AREA FUTURE DEVELOPMENT
SCENERIO
Development Presentation has three parts:

• **Block 14/10 Sea Lion Main Complex**
  – Cover all the salient factors involved in an offshore development in the North Falkland Basin

• **Block 14/10 Area Development**
  – Examine a development scenario which would cover the prospectivity within the southern part of licence 032

• **Block 14/5 Johnson Gas Condensate Prospect**
  – Outline scenarios which are being considered for the Johnson Gas Condensate Prospect
DEVELOPMENT
SEA LION MAIN COMPLEX – CONCEPT PHASE

• Sea Lion Main Complex Introduction
• Base Case Development
• North Falkland Basin Metocean Conditions
• Oil Sales and Trading
• Logistics and Infrastructure
• Project Schedule
• Summary
DEVELOPMENT
SEA LION MAIN COMPLEX INTRODUCTION
DEVELOPMENT Introduction
SEA LION FIELD DEVELOPMENT CONCEPT PHASE
TIMING AND PROGRESS

• The Concept Phase has been ongoing since May 2011
• Concept Phase is divided into two parts
  – Concept Screening
  – Concept Engineering
• Screening completed – 13 options considered and 3 taken forward to Concept Engineering
• Aim to complete Concept Engineering by end 2011 with the selection of the Development Case
DEVELOPMENT Introduction
SEA LION OVERVIEW

• Sea Lion Main Complex has:
  – A relatively large Mid Case areal extent @ 68 sq km with little to no faulting
  – Large continuous sand layers varying in thickness over the field 25m – 90m with good porosity @ 21% and good permeability @ 200md
  – Under saturated reservoir @ 100 bar, low gas oil ratio of 280
  – Water leg which gives ease of application of pressure support through water injection
  – High flow rates are achievable @ 9,000 bopd in thicker sections from vertical wells
  – Ability to drill the reservoir sections with high deviation / horizontal wells in any direction

• The above Subsurface and Well characteristics along with the remote location and 450m water depth lends itself to a development concept of subsea wells tied back to an Floating, Production, Offloading, and Storage Vessel (FPSO)
DEVELOPMENT introduction

TYPICAL FPSO FIELD DEVELOPMENT – FOINAVEN WEST OF SHETLAND
DEVELOPMENT
SEA LION BASE CASE FULL FIELD DEVELOPMENT CONCEPT
DEVELOPMENT
LOCATION – FPSO

Sea Lion Development - FPSO
FPSO with Full Processing & Inherent Storage, No Platform
Drilling, Artificial Lift, Production Trees (Wet), GI and WI Trees (Wet)
Artificial lift options - Gas Lift (shown), ESPs, HSPs
DEVELOPMENT
SEA LION FIELD DEVELOPMENT CONCEPT PHASE
STUDIES

TECHNICAL STUDIES
• Facilities and Subsea concept developments and cost
• Well concepts in conjunction with the above field developments and cost
• VLCC Motion Characteristics, Mooring and Offloading Study
• Geotechnical Studies and Foundation Analyses
• Definition of Meteorological Conditions
• Wax, Emulsion, Water Scaling, Corrosion and Erosion Studies

MARKETING STUDIES
• Crude Assay
• Crude Marketing

• Total forecast spend for Concept Phase ca. GBP 2.5mm 2011
DEVELOPMENT
SUBSEA WELLS TIED BACK TO FPSO
DEVELOPMENT CONCEPT – 350 mmbbl oil recoverable

• WELLS – production, water and gas injection
  – 24 production wells from 4 subsea manifolds (15 mmbbl/well)
  – 12 water injection wells from 2 subsea manifolds
  – 1 gas injection well

• ARTIFICIAL LIFT – normally pressured reservoir and waxy crude
  – Hydraulic Submersible Pumps – HSPs
  – Electrical Submersible Pumps – ESPs
  – Gas Lift

• DESIGN THROUGHPUT
  – Oil rate in the region 108,000 - 120,000 bopd
  – Water Injection rates in the region 135,000 – 150,000 bwpd
  – Gas Injection rates in the region of 25 – 30 mmscfd
  – Produced Water Rate in the region of 120,000 bwpd

• STORAGE AND PARCEL SIZE
  – STORAGE @ 1,500,000 bbls (converted VLCC)
  – PARCEL SIZE likely to be c. 1,000,000 bbls (Suezmax)
DEVELOPMENT
SEA LION DEVELOPMENT
SCHEMATIC – FPSO

(Full Processing, HSP/GL/ESP, Gi, WI – Subsea, Wet Prod. Trees)
DEVELOPMENT
FPSO
SEA LION MAIN FAN COMPLEX (Leased)
DEVELOPMENT

VERY LARGE CRUDE CARRIER – Conversion from trading tanker to FPSO
## DEVELOPMENT
### TYPICAL FPSO FIELD – FOINAVEN

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>FOINAVEN</th>
<th>SEA LION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Location</td>
<td>190 km west of Shetland</td>
<td>200 km north of Falkland</td>
</tr>
<tr>
<td>Water Depth</td>
<td>455m</td>
<td>450m</td>
</tr>
<tr>
<td>Estimated Oil Reserves</td>
<td>380 mmbbl</td>
<td>350 mmbbl (resource)</td>
</tr>
<tr>
<td>Estimated Gas Reserves</td>
<td>230 bcf</td>
<td>95 bcf</td>
</tr>
<tr>
<td>Discovered</td>
<td>1992</td>
<td>2010</td>
</tr>
<tr>
<td>Development Consent</td>
<td>1994</td>
<td>@2013</td>
</tr>
<tr>
<td>First Oil</td>
<td>1997</td>
<td>@2016</td>
</tr>
<tr>
<td>Production</td>
<td>120,000 bopd</td>
<td>120,000 bopd</td>
</tr>
<tr>
<td>Water Injection</td>
<td>170,000 bwpd</td>
<td>150,000 bwpd</td>
</tr>
<tr>
<td>Gas Compression</td>
<td>114 mmrsf</td>
<td>28 mmrsf</td>
</tr>
<tr>
<td>Export Parcel Size</td>
<td>280,000 bbls</td>
<td>@1,000,000 bbls</td>
</tr>
<tr>
<td>Oil Storage</td>
<td>280,000 bbl</td>
<td>1,500,000 bbl</td>
</tr>
<tr>
<td>Drill centres</td>
<td>4</td>
<td>6</td>
</tr>
<tr>
<td>Production Wells</td>
<td>22</td>
<td>24</td>
</tr>
<tr>
<td>Water Injection Wells</td>
<td>9</td>
<td>12</td>
</tr>
<tr>
<td>Gas Disposal</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Length</td>
<td>240m</td>
<td>@320m</td>
</tr>
<tr>
<td>Breadth</td>
<td>34m</td>
<td>@55m</td>
</tr>
<tr>
<td>Depth</td>
<td>13m</td>
<td>@30m</td>
</tr>
<tr>
<td>Topside Load</td>
<td>12,000 tonnes</td>
<td>@12,000 tonnes</td>
</tr>
<tr>
<td>Accommodation</td>
<td>75</td>
<td>@75</td>
</tr>
</tbody>
</table>
DEVELOPMENT
AREAS OF STUDY – Concept Engineering – Subsea and Wells

• SUBSEA and WELLS – Flow Assurance Steady State
  – Waxy nature of the crude @ 20%
  – Pour Point 30 @ degC
  – Sea Lion 14/10-5 well test had arrival temperatures above 65 degC
  – Testing of pour point depressants / wax inhibitors

• SUBSEA and WELLS – Transient Analysis
  – Transient Analysis looks at the dynamic conditions of Start Up and Shutdown for wax deposition
  – Wax mitigation
    • Flushing through the flowline
    • Round trip pigging
    • Additional heat – insulation or heat tracing
    • Chemical injection – either continuous or discrete
DEVELOPMENT
AREAS OF STUDY – Concept Engineering – Facilities and Subsea

• FACILITIES – OIL PROCESS
  – Maintaining temperatures
  – Oil and water separation

• GEOTECHNICAL FOUNDATION STUDIES
  – Suction pile
  – Driven pile
  – Anchor

• SUBSEA INFRASTRUCTURE – INSTALLATION DRIVERS
  – Flexibles
  – Hardpipe reel

• MARINE STUDIES
  – Mooring Analyses
  – Offloading Analyses
DEVELOPMENT
AREAS OF STUDY – Concept Engineering – Wells

• WELL STABILITY – Well Stability/Rock Mechanics
  – High formation integrity negates any sand control requirements
  – Formation integrity allows for the ability to drill the formation in any direction and any angles allowing full access to the reservoir
  – Directional wells through the formation are feasible increasing the productivity index of the well
    • Slant wells 70 – 85 degrees
    • Horizontal wells

• WELL ARTIFICIAL LIFT
  – Electrical Submersible Pumps
  – Hydraulic Submersible Pumps
  – Gas Lift
DEVELOPMENT
MET OCEAN CONDITIONS

• Data based upon 15 months wave rider buoy information located in block 14/10 in 1998 and 1999

• COMPARISON BETWEEN THE Campos Basin Brazil, North Falkland Basin, Central North Sea, West of Shetland
DEVELOPMENT
METOCEAN DATA

10 min Wind Speed at 10m (m/s)

Significant Wave Height (m)
Swell Wave Height (m)
DEVELOPMENT
MET OCEAN CONDITIONS

Wednesday 2 March 2011 00UTC ©ECMWF Forecast t+048 VT: Friday 4 March 2011 00UTC
Surface: Mean sea level pressure / 850-hPa wind speed
DEVELOPMENT
MET OCEAN CONDITIONS

Wednesday 2 March 2011 00UTC ©ECMWF Forecast t+72 VT: Saturday 5 March 2011 00UTC
Surface: Mean sea level pressure / 850-hPa wind speed
DEVELOPMENT
MET OCEAN CONDITIONS

Wednesday 2 March 2011 00UTC ©ECMWF Forecast t+096 VT: Sunday 6 March 2011 00UTC
Surface: Mean sea level pressure / 850-hPa wind speed
Wednesday 2 March 2011 00UTC ©ECMWF Forecast t+120 VT: Monday 7 March 2011 00UTC
Surface: Mean sea level pressure / 850-hPa wind speed
DEVELOPMENT
MET OCEAN CONDITIONS

Wednesday 2 March 2011 00UTC ©ECMWF Forecast t+144 VT: Tuesday 8 March 2011 00UTC
Surface: Mean sea level pressure / 850-hPa wind speed
DEVELOPMENT
OIL SALES AND TRADING
DEVELOPMENT
SEA LION CRUDE ASSAY

- Medium crude API 29.2
- Wax content c.20%
- Low Sulphur at 0.21%
- Low TAN 0.25

- Initial studies based upon on Gross Product Worth (GPW) analysis indicates that Sea Lion would be likely to trade in a range between 10% discount and 5% premium to Brent FOB – dependent upon the refinery functionality i.e. hydrocracking
• Rockhopper does not currently intend to trade Sea Lion
• Options for trading include
  – Integrated oil company
  – Specialist oil trading company
• Typical time to market by tanker
  – NW Europe  TIME TO MARKET  25 days
  – Gulf Coast  TIME TO MARKET  20 days
  – Far East  TIME TO MARKET  35 days
• CEAG oil trading consultants stated:
  “CEAG is certain that there will be buyers for Sea Lion in ‘traditional’ markets, i.e. the MED, N.W.E. and the USA”
DEVELOPMENT LOGISTICS AND INFRASTRUCTURE – PRODUCTION & DEVELOPMENT REQUIREMENTS
During production phase

• Typical FPSO requirements during production phase
  – Resupply @ 2 weeks
  – Personnel movements @ 1-2 flights/week
• 75 people offshore on FPSO
• 20 people offshore on multifunctional support vessel
• 12 people offshore on platform supply/standby vessel
• 40 people onshore – predominantly in logistics and supply services
• This is well within the capabilities of the existing infrastructure
DEVELOPMENT
LOGISTICS AND INFRASTRUCTURE – DEVELOPMENT & PRODUCTION REQUIREMENTS

During development

• The Project Execution Plan outlines
  – Semi submersible Pre drilling of production/injection wells with 1 rig
    @ 1 year prior to first oil
  – 4 month period of installation and hook up and commissioning
  – First oil
    – Additional semi submersible for development wells 2 rigs @ 2 years
• Subsea Installation Vessels – heavy lift, reel/pipe lay, vessel, umbilical lay, survey
• Large reel/carousel equipment needs to be transferred – this will be carried out in
  sheltered waters
• Storage could be managed via floating warehouses and barge
• Offshore activity would peak at @ 300 people
• Onshore support would peak at @ 80 people
DEVELOPMENT

POTENTIAL TIMETABLE FOR DEVELOPMENT
DEVELOPMENT
POTENTIAL TIMETABLE FOR DEVELOPMENT
Possible Full Field Development Schedule

- Complete Concept Engineering Studies 4Q 2011
- Award Subsea FEED 1Q 2012
- Award Facilities FEED 2Q 2012
- Complete FEED 4Q 2012
- Approval* of Field Development Plan and major FPSO and Subsea Contract awards 1Q 2013
- Fabricate Subsea Equipment and install 2nd Half 2015
- Fabricate, Install and Hook Up and Commission FPSO 4Q 2015
- First oil 2016

- The above timescale includes contingency for a new area operation

*Falkland Island Government Licence Conditions
  Regulatory requirement for submission of Field Development Plan April 2013
DEVELOPMENT
SEA LION FIELD DEVELOPMENT
SUMMARY

• Concept work has been progressing since May 2011, work on-going for completion end 2011
• Multiple studies are being carried out with anticipated outturn cost for 2011 @ GBP 2.5million
• Approximately 2,000 engineering man-hours will have to be liquidated by end of 2011
• No technical issues have been found that would prevent development
• North Falklands location not considered difficult for development
• Normal FPSO development
• Sea Lion Crude is attractive to refiners in multiple locations
• No show stoppers
DEVELOPMENT
FPSO (Leased)
PHASED DEVELOPMENT

- Green: Oil Production
- Red: Power Water to HSP/Gas
- Blue: Lift/Electrical Cable to ESP
- Water Injection
- FPSO
- Riser Base Manifold
- Oil Production Manifold
- Water Injuction Manifold

SEPTEMBER 2011
160
DEVELOPMENT
BLOCK 14/10 AREA DEVELOPMENT
• This is a snapshot of the potential future
• Using the standard concepts presently being engineered
• Repeating of known designs will decrease risk and costs from lesson learnt
DEVELOPMENT
14/10
AREA DEVELOPMENT

- Oil Production
- Power Water to HSP/Gas
- Lift/Electrical Cable to ESP

- FPSO
- Riser Base Manifold
- Oil Production Manifold

SEPTEMBER 2011
163
DEVELOPMENT
JOHNSON GAS CONDENSATE DEVELOPMENT PLANNING
DEVELOPMENT
JOHNSON GAS CONDENSATE SCOPING PHASE
OVERVIEW

Johnson is a Gas Condensate field of unknown quantity and fluid properties in 500m of water. Scoping and pre concept screening work has been carried out to attempt to qualify a development.

• Examine feasibility of potential development scenarios
• For the scenarios work develop a cost basis for input scoping economics
• Establish the minimum volume of resource which would meet hurdles for project economics
• Recycle the information into a decision on potential for success to make recommendation (or not) to drill an exploration well
DEVELOPMENT
JOHNSON SCOPING PHASE
ASSUMPTIONS

• GAS VOLUMES Trillion Cubic Feet (TCF)
  – Range from 3 TCF – 30 TCF
  – Use of 5 TCF and 10 TCF in the scoping studies

• CONDENSATE VOLUMES Million Barrels (MMBBL)
  – During the drilling of the Shell 14/5-1 well significant high end C2 – C6 gas shows were recorded
  – Gas Condensate Ratio bbl/mmscf range 25 / 50 / 100
  – Condensate Volumes range 125 – 1,000 MMBBL

• RESERVOIR CONTINUITY AND WELL PRODUCTIVITY
  – Well capacity of 50 – 60 mmscfd and average 20 mmscfd over 20 year field life
  – Equivalent to @180 BCF / Well

• 6 POTENTIAL SCENARIOS REVIEWED – 2 taken forward for economic analysis
  – Floating Liquid Natural Gas (FLNG)
  – Onshore Liquid Natural Gas (LNG)
DEVELOPMENT

JOHNSON FIELD DEVELOPMENT SCENARIO – OFFSHORE FLOATING LNG
DEVELOPMENT

JOHNSON FIELD DEVELOPMENT SCENARIO – ONSHORE LNG

- 500 m Water Depth
- 250 km x 30” Pipeline to Falklands
  >70 barg arrival pressure

- Semisub FPU (or TLP)
- TEG Dehydration
- 125 barg export compression