CLOV, SUCCESSFUL STORY OF DEEP OFFSHORE PROJECT

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KEY DATA

- 140km offshore Angola
- 4th deep offshore development pole, Block 17
- 4 fields: Cravo, Lirio, Orquidea & Violeta
- Water depths: 1,100 to 1,400m
- 2P reserves: 505 Mbbls over 20 years
- Oil production: 160 kb/d at plateau
- Partners: Statoil, Esso, BP
- Concessionaire: Sonangol
- 8.4B$ project (to First Oil)
- Contacts award: July 2010
- First Oil: June 2014 (47 months execution)
KEY DATES

July 2010 > Contracts award
June 2011 > FPSO construction start-up
March 2012 > Hull launching
August 2012 > Drilling campaign start-up
December 2012 > Offshore campaign start-up
August 2013 > FPSO sail away from Korea
November 2013 > FPSO arrival in Angola
> 1st module integration in-country
December 2013 > 1st Riser Tower installed
January 2014 > FPSO sail away Block 17
June 2014 > First Oil
September 2014 > Plateau production reached
October 2014 > Water injection beginning
KEY CHALLENGES

- Water depths 1,100 to 1,400m
- Four fields, 381km² of Development Area
- Commingled production of 2 types of oil
- Selective completions for wells (7)
- No flaring, full gas export
- All-electric FPSO with Variable Speed Drives
- Subsea Multiphase Pumps (1,170m WD)
- High local content scope of work
  - 10 million man-hours in-country
  - 64,000 tonnes of construction and assembly
  - 20% of global cost of the project spent in Angola
TEAM LOCATION AND MAIN SITES DURING PROJECT EXECUTION
Miocene Reservoirs Orquidea-Violeta Central

- Lower quality oil (20°-32° API) & higher viscosity
  - 1/4 of total reserves
  - Reservoir depth ~ 2100 m MSL
  - Lower reservoir pressure of ~200 bar
  - Temperature of ~50°C

Oligocene Reservoirs Cravo, Lirio, O11W

- High quality oil (32°-35° API) and low viscosity
  - 3/4 of total reserves
  - Reservoir depth ~ 2830 m MSL
  - Satisfying reservoir pressure of ~300 bar
  - Temperature ~75 to 80°C

Commingled production of Oligocene and Miocene oils
DRILLING AND WELLS

- 34 wells drilled with 2 Drill ships with dynamic positioning

- Reservoir water depth of burial 850 to 1,800m below seabed

- More than 2,500 days of drilling campaign
  - 2 Rigs mobilized since drilling campaign start-up (August 2012)
  - Light intervention Vessel (well clean up)
SUBSEA PRODUCTION SYSTEM

- 19 production wells
- 15 water injection wells
- 8 manifolds
- 1 Multiphase pumps system

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SUBSEA PRODUCTION SYSTEM EXECUTION

- Fabrication of Well-heads, Xmas trees and appurtenances in Scotland and mainly assembled in Angola

- Manifolds
  - 1 fabricated in Norway (Greenland)
  - 7 fabricated in Angola (Sonamet yard, Lobito)
MULTIPHASE PUMPS

- **Add hydraulic energy** to an unprocessed production stream
- Make **greater pressure drops** possible before separation in a processing facility
- Special interest in deepwater, as well as onshore in remote or hostile environments

- Helico-axial multiphase pumps (3 pumps) in subsea environment is a 1st for Total (1 170m WD)
- Installed on seabed, the MPPs add hydraulic energy to increase the pressure of the Miocene oil from Orquidea and Violeta reservoirs

The ability to boost multiphase fluids has other interesting characteristics:

- Produce low-pressure reservoirs
- Enhance recovery
- Increase pressure drop before liquid-gas separation
- Reduce costs

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MULTIPHASE PUMPS SYSTEM FABRICATION AND INSTALLATION

- Multiphase pump system fabricated in Norway (FDS and helico-axial pumps)
- Foundation fabricated in Angola (Petromar, Soyo)
- Module installed in August 2013 and pumps to be installed in the coming months
FLOATING PRODUCTION STORAGE & OFFLOADING

- Hull 305x62x31m
- Single train process and storage for commingled crude oils
- Oil production: 160 kbo/d
- Oil storage: 1.78 Mb
- Oil-water separation in the hull: wash tanks and settling tanks
- 11 topsides modules
- All-electric concept with Variable Speed Drives
- Gas treatment: 6.5 Msm3/d
- Living Quarters: 240 POB
FPSO CONSTRUCTION

- Built both Korea and Angola
- Hull first steel cutting in July 2011
- Hull launching in March 2012
- Topsides lifting Summer-fall 2012
- Tow from Korea to Angola completed in 75 days
- First FPSO docked in Angola in November 2013
- First integration in-country of Topside module locally fabricated
- 17 million of man-hours achieved without LTI
LOCAL CONTENT, A HIGH SCOPE OF WORK

- 64,000 tonnes of fabrication and assembly
- 10 million man-hours achieved in Angola
- Important yards upgrades
- For FPSO, fabrication and onshore integration of topside module
- For SURF Package, 40,000 tonnes of fabrication
- 7 out 8 manifolds
- 15 out 34 Xmas Trees assembled
FOCUS ON PAENAL YARD – FIRST FPSO BERTHED IN ANGOLA

- **Yard upgrade**
  - Quay 80m → 480m
  - Heavy Lift Crane 2,500 T
  - Capacity 2,5 million man-hours per year

- **Work scope**
  - 7,700 T of fabrication & assembly
  - 3,600 T of integration (including topside module)
  - 1,5 million man-hours achieved without Lost Time Injury
FOCUS ON SONAMET YARD – SUBSEA FACILITIES

● Work scope
  - 23,000 T of fabrication
  - 26,000 T of assembly
  - 4 million man-hours achieved

● Yard upgrades
  - Reconditioning of riser assembly line, upgrade of double-jointing line, new white room
  - New heavy lift crane 750 T capacity

● Manpower
  - 84% Angolanization
  - Welding school with capacity to train 80 welders and pipefitters

Sonamet yard, overview
Riser assembly line and pile lifting

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HSE, A CONTINUOUS EFFORT

- At every stage of the project
- Initiate audit process
- Apply HSE management system
- Involve and motivate contractors
- Promote human factor and behaviour initiatives
- Apply and promote TOTAL’s golden rules
- Good performances for CLOV
CLOV STORY, THE FILM
MERCI

THANK YOU
Proudly CLOV

- June 2014 marked the safe and timely delivery of the largest SURF project ever executed by Subsea 7: CLOV
- Full EPCI scope covered, from design to offshore performance guarantee test
Schedule challenge

- 750 000 engineering manhours, 95% in-house
- 5 500 documents issued by Subsea7
- 5 300 documents issued by suppliers
- 150 purchase orders for permanent work (730 for installation aids) – 120 000 SCM manhours
- 8 000 quality inspections
- Nearly 77 000 freight tonnes
Riser systems: 2 Hybrid Riser Towers (HRT) and 1 Single Hybrid Riser (SHR)

Concepts fully developed in-house, and optimized to suit CLOV specificities
HRT – Cross section principles

- Production riser: gas lift flowing in the annulus of a wet insulated Pipe In Pipe
- Stability during towing; bundle is slightly buoyant
- Foam block as simple as possible:
  - Tightened around the core pipe and secured axially against guide frames
  - Simple shape with external risers (offering in service visual)
- Hydrodynamic optimization of foam distribution (VIV, galloping)
HRT – Polyurethane Guide Frame

PU guide frame qualified for the project, extensively tested to destruction offering light weight, easy assembly and dimensional consistency
HRT : innovative Buoyancy Tank

Passive buoyancy (foam) combined with steel compartments

=> slightly buoyant when flooded to lower operational risk
Flowlines

• 130km of production, water injection and gas export flowlines
• 53 subsea structures, 25 different types
• High performance pipe in pipe for production loop
• Design and installation of pipe walking and lateral buckling mitigations
Spools and well jumpers

- 52 spools and well jumpers (mono and multibore)
- Congested layout at HRT base: compact spools accommodating riser and flowlines expansion, HRT dynamic motions and slugging loading.
Umbilicals

- 83km of umbilicals fabricated in Angoflex, Lobito
- Dynamic and static sections, In-line Connection Units
All CLOV fabrication by Sonamet, in Angola

4 million manhours without LTI
Deliver on time to secure offshore schedule
Operations overview
• 1.8 million man hours with no LTI
• 1280 construction vessel days
• 3180 cargo barge days
• 4400 tug days
Seven Borealis: a brand new vessel

- J-Lay, SHR, arches, large spools, piles and manifolds
- Very challenging first operations with heavy PIP
- Fast learning curve
Seven Eagle

Flexible pipes, umbilicals, spools and jumpers, SIV, gas export dewatering, SHR diving and assistance to HRT towing
Rockwater 2

Saturation diving
Acery Legend, Seisranger, Simar Esperança

Long base line, surveys, pre-commissioning, de-ballasting of HRT tanks, flying leads
Conclusion: what CLOV has demonstrated

• The high level of safety and performance achieved with proper preparation
• The efficiency of integrated teams to cover complex and large EPCI scopes: transparency and collaboration with our client is key
• The capability of Sonamet yard to deliver on time and according to stringent standards
• The capacity of Subsea7 to deliver complex EPCI projects within schedule at Client satisfaction