Block 15-06 East Hub Development Project
Armada Olombendo FPSO – Naming Ceremony

Singapore - 14th October 2016

FPSO Project in brief

The FPSO has been converted from an existing double-hull trading tanker "ARMADA ALI" (ex. "M.T. OSPREY") and is classified by ABS with facilities to perform the following main functions:

- Receive produced fluids from subsea fields and process the produced fluids
- Treat and inject produced water and/or sea water for reservoir pressure maintenance
- Treat and manage produced gas for injection
- Store treated oil and offload oil to shuttle tankers

The FPSO will be located in approximately 450 m water depth at south-east of Cabaça North field and at north-east of Cabaça South-East field. The FPSO is owned by Bumi Armada and its conversion has been undertaken in Singapore at Keppel Shipyard. Process Modules have been fabricated at Dyna-Mac Yard. Sonamet Yard at Lobito (Angola) has fabricated 5 Topside Modules and the suction piles for the mooring of the FPSO at the offshore site.

Vessel Info

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<tr>
<th>Year of Fabrication: 1999</th>
<th>Deadweight Tonnage: 302,000</th>
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<tbody>
<tr>
<td>Classification: ABS</td>
<td>Overall Length: 382 m</td>
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<tr>
<td>Design Life: 20 years</td>
<td>Breadth: 58 m</td>
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<tr>
<td>Water Depth: 450 m</td>
<td>Storage Capacity: 1,700,000 bbls</td>
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FPSO nameplate capacities

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<tr>
<th>Crude Oil Production: 80,000 bbls/d</th>
<th>Water Injection: 120,000 bbls/d</th>
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<tr>
<td>Total Liquid Production: 110,000 bbls/d</td>
<td>Total Gas Production: 120 mmscfd</td>
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<tr>
<td>Prod. Water Production: 90,000 bbls/d</td>
<td>Gas Injection: 100 mmscfd</td>
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<td>Main Power Generation: 3x21 MW Dual Fuel Turbines</td>
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Armada Olombendo FPSO - HSE Commitment

Project Management Commitment: demonstrate leadership on site encouraging people to work in a safe manner with personal examples and conducting regular site inspections with provision of relevant observations.

Eni Hand Safety Campaign
FPSO Project HSE Performances at 30th September 2016

Total Project Manhours (including Sonamet Yards): 17,740,764

Total manhours w/o LTI at Singapore Yards: 17,038,323

Lost Time Injury Frequency Rate (LTIFR): 0.06

Total Reportable Injuries Rate (TRIR): 0.40

First Aid Case Rate (FACR): 0.06

“The Mass Toolbox Talk at Keppel Shipyard takes place every Monday morning and involves all the Armada Olombendo FPSO project work force. Positive and Negative observed behaviors are discussed by all managers with the workers in order to reinforce the safety culture of the worksite.”
“After the completion of the Integration and Commissioning activities at Keppel Shipyard, the FPSO will sail to the Offshore Site in Angola in about 40 days. Once Offshore, the FPSO will be hooked-up to the pre-installed mooring system and subsequently all the preparatory activities will be completed to have the FPSO Ready for SURF Hook-up (connection of the FPSO to the Subsea, Umbilicals, Risers and Flowline system)”
### FPSO Project Execution Strategy

**Chennai - India**
- Detailed Engineering for Topside Modules and Turret

**Kuala Lumpur - Malaysia**
- Process Engineering
- Interface Management
- Procurement

**Lobito - Angola**
- Topside Modules Fabrication
- Suction Piles Fabrication
- Preparation for Mooring System Installation

**Singapore**
- Project Management
- Marine System Refurbishment and Hull Conversion
- Turret and Topside Modules Fabrication, Integration, Mechanical Completion, Pre-Commissioning and Commissioning Activities

### Construction and Completion Strategy

**Keppel Shipyards**
- Hull conversion and Marine System refurbishment works
- Turret Fabrication
- Utilities Modules Fabrication
- Integration and Mechanical Completion

**Sonamet Yard**: 9 Suction Piles and 5 Topside Modules

**Dyna-Mac Yard**: 6 Process Modules

**ABB/Mc Pec Yard**: E-House Module

**Boskalis**: Offshore Mooring System Installation and FPSO Hook-up

**Bumi Armada** is responsible for all activities and provide all services required for the pre-commissioning and commissioning activities for all systems and subsystems of the FPSO.

*“Most part of the fabrication activities of the entire FPSO project are executed in Singapore in two main yards (Keppel Shipyards and Dyna-Mac Yards)”*
Keppel Shipyard Detailed Scope of Work

Hull conversion and marine system refurbishment

- Bow Modification and Hull Steel Renewal
- Rigid Arm Fabrication and Installation
- New emergency diesel generators
- Accommodation upgrade
- CCR for topside monitoring and control system
- Main engine retained for self-propulsion voyage to site
- Modification of deck arrangement to cater for the installation of the topside modules
- Modification of the instrumentation and control systems
- New deck pedestal cranes and Helicopter deck with supporting structures

“As part of the Steel Renewal Scope, Keppel Shipyard has executed the full condition assessment of the hull to determine all the area subject to repair or replacement”
Turret Fabrication

- Turret Head
- Turret Shaft
- Turret Decks
- Gantry Structure
- Swivel Installation

Topside modules fabrication

- Commissioning Laydown Area
- Flare Tower
- Flare KO Drum Module
- Utilities Module
- Produced Water
- Methanol Injection Module
- Essential Diesel Generator
- Inlet Manifold Module

“Keppel Shipyard has also performed the overall Topside Modules and Turret Integration activities up to the final Mechanical Completion while Pre-commissioning and Commissioning activities are executed under Bumi Armada responsibility”
"After completion the Topside Modules have been loaded out from Dyna-Mac Yard and lifted onboard the FPSO at Keppel Shipyard using Heavy Lift Floating Cranes"
Main achievements at Dyna-Mac Yard

“Exotic Piping pre-fabrication has been performed at Dyna-Mac Pandan (West Yard) in a dedicated Air-Conditioned Exotic Piping Workshop”

- Mar. 2016 – Power gen. module load out
- May 2016 – Water injection module load out
- May 2016 – Production separation module load out
- Jun. 2016 – Gas compressors scrubbers/coolers module
- Jun. 2016 – Gas compression module load out
- Jun. 2016 – Oil stabilization module load out
"The Lifting and positioning of the Rigid Arm Block 2 was executed using Asian Hercules III (5,000 tons capacity) and it has been among the most challenging lifting of the entire project."

Heavy Lifting Campaign - Main Achievements - 2014/2015

- Dec. 2014 - Rigid arm block-1
- Jun. 2015 - Methanol tank
- Jul. 2015 - Laydown area (m96)
- Jul. 2015 - Rigid arm block-2
- Sep. 2015 - Seawater lift pumps caissons
- Dec. 2015 - Rigid arm block-3
- Nov. 2015 - Helideck
Heavy Lifting Campaign - Main Achievements - 2016

"E-House Module fabrication and mechanical completion by ABB and Mc Pec Yard was achieved in a record time of 8 months. The timely achievement of the lifting milestone of the E-House has allowed to start timely the electrical integration activities onboard the FPSO which are critical for the project completion."

"The Topside Utilities Modules have been fabricated at Keppel Shipyards (East Yard Area) and subsequently lifted onboard for final integration and commissioning."

- Jan. 2016 - E-House module
- Jan. 2016 - Fiscal metering module
- Jan. 2016 - Utilities module
- Feb. 2016 - Essential diesel generation module
- Feb. 2016 - Flare system module
"The Power Generation Module was fabricated at Dyna-Mac Yard. Shifting of the module (weight of 1,890 tons) inside the yard and its lifting were extremely challenging activities completed safely."
“The lifting of the Turret Head and Shaft on the rigid arm has been among the major heavy lift executed for the entire project (2,272 tons)"
“Production Separation Module was fabricated at Dyna-Mac Pandan Yard (West Yard). Module has been transported to Keppel Shipyard through barge and then lifted onboard using Asian Hercules II Crane”
“The lifting of the Swivel and of its access structure has presented several challenges due to the overall height of the assembly on top of the decks and Lower gantry structure”
Local Content - Main Achievements:
9 Suction Piles completed

“As part of the Local Content Plan, several fabrication activities have been executed in Angola at Sonamet Yard in Lobito. 9 Suction Piles for the mooring of the FPSO have been completed at Sonamet Yard”
Local Content - Main Achievements:
5 Topside Modules completed

“Five Topside Modules have been fully fabricated in Angola at Sonamet Yard in Lobito. Modules were completed on schedule in December 2015 and delivered to Keppel Shipyard for final integration”
Main Applied Technologies - Main Roller Bearing - (ThyssenKrupp Rothe Erde)

"Main Roller Bearing system comprises of a segmented three (3) raceway roller bearing system located on the turret head and shaft structure. The slewing bearing is designed in such a way that it will transfer loads to the FPSO hull through the turret head structure and resist the horizontal, vertical and radial loads"
Main Applied Technologies - Sulphate Removal Membranes (Veolia)

“The Sulphate Removal membrane units are designed to achieve a guaranteed sulphate level in the injection water of < 20 mg/l to avoid scale deposition into the reservoir. The nanofiltration membrane is arranged as a spiral-wound element. A housing vessel contains 6 elements in series with the feed being introduced at one end of the vessel, the reject being collected at the opposite end and the permeate collected in a central annular tube”
Our Mission

We are an energy company.

We are working to build a future where everyone can access energy resources efficiently and sustainably.

Our work is based on passion and innovation, on our unique strengths and skills, on the quality of our people and in recognising that diversity across all aspects of our operations and organisation is something to be cherished.

We believe in the value of long term partnerships with the countries and communities where we operate.