TECHNOLOGICAL CHALLENGES
IN PRE-SALT AREA

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AGENDA

- GENERAL DATA – TUPI AND IARA AREA
- DEVELOPMENT STRATEGY
- TECHNOLOGICAL CHALLENGES
- CONCLUSIONS
GENERAL DATA
General Data - Tupi Area

- Petrobras (65%), BG (25%), Petrogal (10%)
  - Heterogeneous layered carbonates – microbiolates with variable reservoir quality
  - Water Depth about 2,200 m
  - Salt layers with thickness – up to 2,000 m
  - Well tests indicate potential flow rates of 15-20 k bopd
  - API: 28-30°

- Oil viscosity around 1 cP
- GOR around 230 m³/m³
- Initial pressure 580 kgf/cm²
- Low TAN (Total Acid Number)
- CO2 in the associated gas (Tupi: 8 - 12%)
- Concern with flow assurance due to wax deposition in pipes
General Data - Tupi Area

- **Selected Area for the Pilot:** 115 km²
- **Area of the Appraisal Plan:** 1974 km²
- The main reservoir in the Pre-Salt is known as the SAG reservoir.
- Two other carbonate reservoirs are found in the area (RIFT, COQUINAS).
- The preliminary estimates for the recoverable volume for the whole Tupi area are between 5 and 8 billion bbl.
General Data - Iara

- Petrobras (65%), BG (25%), Petrogal (10%)
- Area of the Appraisal Plan: 300 km²
- The preliminary estimates for the recoverable volume for Iara area are between 3 and 4 billion bbl
- Water Depth about 2,230 m
- Reservoir Depth about 6,080 m
- API: 26-30°
DEVELOPMENT STRATEGY
Development Strategy (Ex: Tupi)

Phases

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<thead>
<tr>
<th>Phases</th>
<th>Information Acquisition</th>
<th>Definitive Development</th>
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<td>Phase 0</td>
<td>EWT (Mar/2009), Tupi Pilot and Appraisal Wells</td>
<td>Implementation of “X” production units (Replicant FPSOs)</td>
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<td>Phase 1A</td>
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<td>• Implementation of “Y” production units.</td>
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<td>Phase 1B</td>
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Focus

- Area Delimitation
- Analyse reservoir flow
- Fractured Well performance
- Complete sampled core
- Material analysis X CO2

Objective

- Analyse water and gas/CO₂ injection behavior
- Test adjustments on FPU related to CO₂
- Test improvements in well projects
- Apply previous dominated concepts and technologies with necessary adjustments to reach a significant production by 2017
- Aggregate innovative technical solutions to optimize project performance

Significant production level

2007 2009 2010 2012 2017

1st Oil – EWT Tupi (Mar/09) 1st Oil – Tupi Pilot (Dec/10)
Development Strategy by Phases

Phase 0: Information Acquisition
- 11 Tupi
- 9 Carioca
- 10 Parati
- 9 Guará
- 21 Caramba
- 8 Bem-Te-Vi
- 11 Iara
- 24 Jupiter

Phase 1 – Definitive Development
- 8 FPSOs
- Gas Transp.1a + Oil Transp.1a + Infra + Oil Utilization1a + Gas Commercialization 1a
- “N” FPUs + Gas Transp.1b + Oil Transp.1b + Oil Utilization1b + Gas Commercialization

Significant production level
TECHNOLOGICAL CHALLENGES
Reservoir Characterization and Engineering

- Facies definition from seismic data.
- Internal reservoir characterization, with focus on the main heterogeneities.
- Secondary recovery: technical feasibility of water and gas injection.
- Geomechanics of the surrounding rocks with depletion.
Technological challenges

Well Drilling and Completion

- Deviation of the wells into the salt zone.
- Hydraulic fracture in horizontal wells.
- Wellbore materials, resistant to high CO2 content.
- Slow penetration in the reservoir.
- Extended Reach Wells.
Technological challenges

Subsea Engineering

- Qualification of risers for water depth of 2,200 m, considering CO2 and high pressure.
- Scenario for riser towers, SCRs with lazy wave, BSR, and other technologies.
- Qualification of thermal insulated flowlines for water depths of 2,200 m.
- Flowlines for high pressure gas injection.
Technological challenges

Flow Assurance and Artificial Lift

- Preventing hydrate formation.
- Wax deposition in long pipelines.
- Scaling control.
- Temperature management along the lines.
Technological challenges

Floating Production Units

- Mooring in water depths of 2,200 m.
- Interaction with the riser’s system.
- Scenario for platforms with direct access to the wells (SPAR, TLP, FPDSO).
Logistics for the Associated Gas

- More suitable materials for equipment dealing with high CO2 concentration gas streams.
- Gas pipeline larger than 18” in water depth of 2,200 m.
- Long distance to shore (300 km).
- Scenario for new technologies offshore: LNG, CNG, GTL, GTW, etc.
Objective:
Develop and disseminate technologies to incorporate reserves and to develop the production of the recent discoveries in the pre-salt section.

Projects’ Portfolio:
- Well construction for the pre-salt section (drilling fluids, cement resistance, stimulation techniques, geomechanical model, liner drilling, well control in the salt zone, multilaterals).
- Geosciences (chemical stratigraphy, core-log-test integration, geomechanical model and fracture distribution, pre-salt imaging, seismic attributes)
- Reservoir Engineering: Recovery optimization
CONCLUSIONS
• Petrobras has a worldwide recognized deepwater experience to address technical and comercial challenges for Pre-salt appraisal and development.

• A new paradigm will be established for conceptual design applied to Santos Basin Pre-salt cluster production development and logistical support.

• There are tremendous opportunities for already installed and newcomers in Brazilian oil&gas equipment suppliers and service companies due to the scale provide by upstream portfolio.

• Pre-salt will start commercial production in 2010, with a steep ramp-up on the following years, reaching a significant contribution to Petrobras oil and gas production throughout next decade, as will be announced by next revision of our Strategic Plan.
Thank you!