OFFSHORE RIGID PIPELINES ENGINEERING
PETROBRAS

FABIO BRAGA AZEVEDO

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The presentation may contain forecasts about future events. Such forecasts merely reflect the expectations of the Company’s management. Such terms as "anticipate", "believe", "expect", "forecast", "intend", "plan", "project", "seek", "should", along with similar or analogous expressions, are used to identify such forecasts. These predictions evidently involve risks and uncertainties, whether foreseen or not by the Company. Therefore, the future results of operations may differ from current expectations, and readers must not base their expectations exclusively on the information presented herein. The Company is not obliged to update the presentation/such forecasts in light of new information or future developments.
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- **Gas**
- **Energy**
- **Distribution**
- **R & D**
EDI
Design of Submarine Pipelines Systems and Submarine Installations Structures and Equipment
Pipeline Design Description
Offshore Pipeline Development

Opportunity Identification

Conceptual Design - Selection -

Basic Design - Definition -

Detail Design - Implementation -

Operation 1º Year
Offshore Pipeline Development

Conceptual Design
- Selection Phase -

E&P (client)
R&D Center

Development of the technical feasibility study
Installation feasibility
Main constraints are addressed
Offshore Pipeline Development

Basic Design - Definition -

- Definition of pipeline system concept
- Development of mechanical design (sizing, materials, thermal analysis, FEA,..)
- Analysis of installation methods
- Perform Qualification trials
- Develop others engineering activities

E&P (client)
R&D Center
Offshore Pipeline Development

- E&P (client)
- R&D Center

Detail Design - Implementation -

- Engineering, Procurement, Construction, Installation and Pre-commissioning
- Conclusion of qualification trials
- Installation details
Pipeline Installation Requirements

✓ Ultra Deep Water
Pipelines subjected to high requirements of axial tension, bending moments and external pressure.

✓ Pipeline Diameter up to 34-in
Fields located far away from shore. Requirements for large diameters export pipelines.

Methods to Install Pipelines

✓ S-LAY
✓ J-LAY
✓ REEL LAY
✓ TOW
Pipeline Installation Requirements

✓ S-LAY method
Pipeline Installation Requirements

- J-LAY method
Pipeline Installation Requirements

✓ REEL LAY method
Projects Been Developed Nowadays

To be completed up to 2013

<table>
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<tr>
<th>Projects</th>
<th>Quantity</th>
<th>Km</th>
</tr>
</thead>
<tbody>
<tr>
<td>Starting phase</td>
<td>5 projects</td>
<td>504,5</td>
</tr>
<tr>
<td>Been developed</td>
<td>15 projects</td>
<td>1149,3 + 137</td>
</tr>
<tr>
<td>Been developed with E&amp;P</td>
<td>3 projects</td>
<td>130 + 20</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>20</strong></td>
<td><strong>1940,8</strong></td>
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</table>

Source: Petrobras Engineer Department Plan
Tupi Export Gas Pipeline

18-in from Tupi to Mexilhão Platform
Depth from 2200m to 172m
Length of 216km
Laid by Solitaire

34-in from Mexilhão to UTGC
Depth of 172m
Length of 137km
Laid by Acergy Piper
Guara / Tupi Export Gas Pipeline

18-in from Guara to Tupi FPSO
Depth of 2200m
Length of 51km
Installation vessel to be defined

18-in from Tupi FPSO to Tupi NE
Depth of 2200m
Length of 20km
Installation vessel to be defined
Sul Norte Gas Export Pipeline

18-in from MOP to PLEM Camarupim
- Depth of 60m
- Length of 151km
- Installation vessel been defined

12-in from P-58 to MOP
- Depth of 1100m
- Length of 50km
- Installation vessel been defined
UOTE Oil Export System

Export and Transfer Offshore Unit

34-in pipelines connecting monobuoys

Depth of 65m

Installation vessel to be defined
Tupi NE / Iracema / Cabiúnas Gas Export Pipeline

18-in from Tupi NE to Iracema
Depth of 2250m
Length of 18km
Installation vessel to be defined

24-in from Iracema to shore
Depth of 2250m
Length of 370km
Installation vessel to be defined

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Design Competition for Riser System of Guara and Tupi NE

Two Technologies Been Developed

BSR Technology (Risers Submersed Buoy) and

Riser Tower

30 risers for Guara and 30 risers for Tupi NE (from 5.56-in to 9.33-in)
10 to 15 insulated production lines (SynPP)

Total Length: 130 km (minimum)

Total of EHU : 15 for Guara and 15 for Tupi NE

Depth of 2200m

First oil: end of 2012
Design Competition - Guara and Tupi Nordeste Riser System

BSR Technology
(Risers Submersed Buoy)

2 Submersed Buoy for each field
Depth of 2200m
Design Competition - Guara and Tupi Nordeste Riser System

Riser Tower Technology

3 riser towers for each field

Depth of 2200m
Design Competition - Guara and Tupi Nordeste Riser System

Riser Tower Technology

Depth of 2200m

First oil: end of 2012
Pipe-in-Pipe System for Canapu

- Pipes: 13,3-in x 8,62-in
- OHTC: 0,8 W/m²K
- Length: 20km and Depth: 1620m
- Now is installed

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The Future
and
Challenges
Pre-Salt Area
Floating Production Units

Mooring in water depths of 2,200m
Scenario to use platforms as SPAR, FPDSO and TLP on pre-salt fields

Subsea Engineering

Qualification of risers/pipelines for water depth of 2,200m, considering CO₂, H₂S and high pressure
Development of high strength steel for offshore pipelines (X70 and X80)
Scenario for Riser Towers, BSRs, SCRs in lazy wave and other technologies
Supply of CRA clad pipes (3mm alloy 625)
Subsea Engineering

Long distances and flow assurance for oil pipelines

Qualification of very high efficient insulation materials for water depths of 2200m

Pipe-in-Pipe Systems (flowlines and risers) with very low U-value

Technical solutions for internal coating of risers and pipelines, field joints, bends

Development of Pre-Salt area with partners and Fast Track Projects
Total Oil and Natural Gas Production
1000 boe

<table>
<thead>
<tr>
<th>Year</th>
<th>Produção de Gás Natural – Internacional (mil boe/dia)</th>
<th>Produção de Gás Natural – Brasil (mil boe/dia)</th>
<th>Produção de Óleo e LGN - Internacional (mil boe/dia)</th>
<th>Produção de Óleo e LGN - Brasil (mil boe/dia)</th>
<th>Produção de Óleo e Gás Natural – PETROBRAS (Brasil + Internacional) (mil boe/dia)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2009</td>
<td>1.071</td>
<td>141</td>
<td>41</td>
<td>141</td>
<td>2626</td>
</tr>
<tr>
<td>2010</td>
<td>2.100</td>
<td>384</td>
<td>55</td>
<td>140</td>
<td>2723</td>
</tr>
<tr>
<td>2011</td>
<td>2.980</td>
<td>176</td>
<td>126</td>
<td>176</td>
<td>3907</td>
</tr>
<tr>
<td>2020</td>
<td>3.950</td>
<td>203</td>
<td>420</td>
<td>203</td>
<td>5382</td>
</tr>
</tbody>
</table>

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Production based on Projects Development

**Source:** Petrobras Strategic Plan 2010-2014

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Petrobras Strategic Plan 2010 - 2014

Investments

Source: Petrobras Strategic Plan 2010-2014

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Petrobras Strategic Plan 2010 – 2014
US$224 bi

- E&P: 33%
- Petroquímica: 8%
- RTC: 1%
- Distribuição: 2%
- Biocombustíveis: 2%
- G&E: 17.8
- Tecnologia (P&D): 53%

Research & Development US$ 5.1 bi

- SMS: 29%
- TIC: 3.3
- Tecnologia (P&D): 5.1
- Corporativo: 25%

Source: Petrobras Strategic Plan 2010-2014
Brazil Oil Industry Human Resources Plan 2010 – 2014

<table>
<thead>
<tr>
<th>HUMAN RESOURCES (1000)</th>
<th>2010 - 2014</th>
</tr>
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<tbody>
<tr>
<td>Direct Working Positions (oil industry)</td>
<td>380</td>
</tr>
<tr>
<td>Indirect Working Positions</td>
<td>542</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>922</strong></td>
</tr>
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</table>

Source: Petrobras Strategic Plan 2010-2014
FUTURE PIPELINE PROJECTS

Brazil Offshore Pipelines

<table>
<thead>
<tr>
<th>Projects (2013 – 2020)</th>
<th>Quantity</th>
<th>Km</th>
</tr>
</thead>
<tbody>
<tr>
<td>Possible Projects</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diameter 10 to 34-in</td>
<td>16 projects</td>
<td>2129</td>
</tr>
<tr>
<td>Depth up to 2250m</td>
<td></td>
<td></td>
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Source: Petrobras Engineer Department Plan
Conclusions

CHALLENGES TO BE OVERCAMED IN NEAR FUTURE:

DEVELOP AND PRODUCE ULTRA DEEP OIL AND GAS FIELDS IN PRE-SALT AREA

LONG DISTANCES IN PRE-SALT AREA

DEVELOP FEASIBLE and RELIABLE RISERS SYSTEMS
Conclusions

CHALLENGES TO BE OVERCAME IN NEAR FUTURE:

ATTEND SCHEDULE OF FAST TRACK PROJECTS WITH PARTNERS

DEVELOPMENT OF NATIONAL SUPPLIERS

TECNOLGY DEVELOPMENT

DEVELOP HUMAN RESOURCES
Many Thanks!

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See you in Rio de Janeiro