"Technological challenges in deep-water oil production and exploration in CPLP (*) - The experience of Technip".

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(*) CPLP – Comunidade dos Países de Língua Portuguesa, Portuguese Language Countries Community
Key Risk Conditions – 12 Safety Actions

The analysis revealed as well, that in many cases accidents could have been completely avoided or at least the consequences could have been minimized by applying the following 12 Safety Actions:

1. **NEVER** perform tasks for which you are not trained and competent.
2. **NEVER** use alcohol or drugs while working or driving.
3. **NEVER** expose yourself or others to the risk of dropped or falling objects.
4. **NEVER** remove safety isolation/equipment /barriers.
5. **NEVER** walk under suspended loads.
6. **NEVER** be exposed to a fall or work at height without protection.
7. **ALWAYS** use the correct tools safely to carry out the job.
8. **ALWAYS** observe the applicable speed limits and driving policies.
9. **ALWAYS** work with the correct Personal Protective Equipment.
10. **ALWAYS** obtain authorisation before entering a confined space.
11. **ALWAYS** intervene when you see an unsafe act or condition.
12. **ALWAYS** perform a HSE Tool Box Talk and work with a permit or safe system of work.

The 12 Safety Actions are mandatory, and must be fully complied with by all Technip Employees, Sub-contractors / Suppliers working for Technip and or visitor that enter any facility/ site that is under the management control of Technip.
1. Briefly of actual market size of oil industry in CPLP (Brazil, Angola and Mozambique)

2. Technological challenges in deep-water oil exploration

3. Technip involvement in CPLP projects
ACTUAL MARKET OF OIL AND GAS INDUSTRY IN CPLP (BRAZIL, ANGOLA AND MOZAMBIQUE)
Oil and Gas in Mozambique

<table>
<thead>
<tr>
<th>Notable oil and gas discoveries</th>
<th>Proposed infrastructure</th>
</tr>
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<tbody>
<tr>
<td>32 – 65 Tcf of recoverable gas resources in Area 1 and 75 Tcf gas in place in Area 4</td>
<td>LNG Plant and supporting infrastructure</td>
</tr>
</tbody>
</table>

- **Proven Natural Gas Reserves (Tcf)**

  - Mozambique reserves include 100 Tcf of 2012 discoveries

<table>
<thead>
<tr>
<th>Country</th>
<th>Proven Reserves (Tcf)</th>
</tr>
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<tbody>
<tr>
<td>Russia</td>
<td>1.582</td>
</tr>
<tr>
<td>Iran</td>
<td>1.046</td>
</tr>
<tr>
<td>Qatar</td>
<td>856</td>
</tr>
<tr>
<td>Saudi Arabia</td>
<td>276</td>
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<tr>
<td>USA</td>
<td>272</td>
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<tr>
<td>Turkmenistan</td>
<td>205</td>
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<tr>
<td>UAE</td>
<td>187</td>
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<tr>
<td>Nigeria</td>
<td>179</td>
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<tr>
<td>Venezuela</td>
<td>159</td>
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<tr>
<td>Algeria</td>
<td>112</td>
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<tr>
<td>Iraq</td>
<td>110</td>
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<tr>
<td>Australia</td>
<td>106</td>
</tr>
<tr>
<td>Indonesia</td>
<td>104</td>
</tr>
<tr>
<td>Mozambique</td>
<td>104</td>
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<tr>
<td>Kazakhstan</td>
<td>85</td>
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<tr>
<td>Malaysia</td>
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<tr>
<td>Egypt</td>
<td>77</td>
</tr>
<tr>
<td>Norway</td>
<td>72</td>
</tr>
<tr>
<td>Uzbekistan</td>
<td>65</td>
</tr>
<tr>
<td>Kuwait</td>
<td>63</td>
</tr>
<tr>
<td>Canada</td>
<td>62</td>
</tr>
<tr>
<td>Libya</td>
<td>55</td>
</tr>
</tbody>
</table>

Source: OPEC-CIA Factbook and SPTEC Advisory estimates

Reserves as of 31/12/2011
Oil and Gas in Angola

- Proven Reserves of Crude Oil (billion barrels) 2012: 9.500
- Production of Oil (‘000 bpd) 2011: 1,840
- Exports of Oil (‘000 bpd) 2010: 1,928
Oil and Gas in Brazil

Petrobras Pre salt in numbers

- Reserves of 50 bn bbl of oil
- Additional production units, but also drilling rigs, tankers, etc.
- 17,000 km of subsea pipelines
- 4.8 Million tons of steel
- 68 Million hours of Engineering
- 1 Bn hours of Construction

Pre-salt development will increase challenges to an already stretched Supply chain in Brazil
Oil and Gas in Brazil
Brazil Pre-salt x West Africa Pre-salt

Map showing the locations of the Brazil and West Africa Pre-salt regions, with key points such as the Whale Park Pre-salt Complex and specific wells labeled with details like "Baleia-1 (1996)" and "Denden-1 (1983)".
Brazil Pre-salt x West Africa Pre-salt

Brazil Pre-Salt
Reconcavo, Sergipe, Alagoas, Espirito Santo, Santos & Campos Basins

West Africa Pre-Salt
Kwanza, Lower Congo, Cabinda Area & Gabon

Jubarte Pre-salt Complex (Brazil, Campos Basin)
~2.7 BBOE *

2 Bbbl *
discovered onshore, Brazil

10-20+ Bbbl *
Ultimate Recoverable in deepwater Santos & Campos

Spreading Center

Ocean

Salt

Sag

Syn-Rift

Play Openers (Angola, Kwanza Basin)
Bicuar-1 & Camela-1

5 Bbbl *
discovered onshore/shelf, West Africa

* Sources: Wood Mackenzie & IHS

Technip
TECHNOLOGICAL CHALLENGES IN DEEP-WATER OIL PRODUCTION AND EXPLORATION
Technological challenges in deep-water oil production and exploration

Aspects that determine the technology in deep-water oil exploration and production in South Atlantic Sea

- Climate, sea environment and rocks conditions
- Big distances in the sea: big distances from the coastal, depth of water column and depth of resevoir
- Invisibility of sea operations
- Contaminant elements presented in the oil and density of hidrocarbons

Need of technological innovation in both exploration and production phases.
Technological challenges in deep-water oil production and exploration

1. Climate, sea environment and rocks conditions

- **Climate, sea environment and rocks conditions such as:**
  - Wind velocity
  - Waves high
  - Sea currents directions
  - Weatherstorms
  - High hydrostatic in sea bed pressure due to the water depth
  - Low temperature in deep sea
  - Plastic nature and behaviour of salt layer during application of strain
  - Structural conditions of sea bed
  - Composition and porosity of sedimentary rocks
Technological challenges in deep-water oil production and exploration

1. Climate, sea environment and rocks conditions

- **Technical innovation in production phase:**
  - Development of thermal insulation in risers in order to avoid hydrates and parafin formation that could obstruct the oil flowlines
  - Development of materials more resistant of fatigue and then avoid ruptures of anchors cables
  - Development of more resistant materials to use in the well lining the salt layer to able to sustain the pressure and the movements of the salt rocks and then avoid the collapse of the wells;
  - Improvement synthetic materials for risers in order to increase their resistance to the pressure of the water column (collapse) and movements of the platform (fatigue).
Technological challenges in deep-water oil production and exploration

1. Climate, sea environment and rocks conditions

- **Technical innovation in exploration phase:**
  - Investigation of new techniques of seismic data acquisition to obtain clearer images of deep sedimentary rocks below the salt layer, in order to reveal geological areas with the possibility of the existence of oil and gas reservoirs;
  - Construction of platforms type Dynamic Positioning (DP) capable of drilling wells up to 10,000 feet depth, in water depths over 3000 meters;
  - Technical innovations in mooring / anchoring semisubmersible drill platforms by developing slight synthetic cables for 2500 meters of water depth;
  - Research of new drilling techniques in horizontal wells in the pre salt carbonate rocks.
Technological challenges in deep-water production and exploration

2. Big distances in the sea

- Big distances from the coastal, depth of water column and depth of reservoir
  - Water depth: around 2000 ~ 3000 m
  - Pre-salt well depth: around 7000 ~ 10000 m
  - Reservoir depth: around 3000 m
  - Distance from the coast: more than 300 km
Technological challenges in deep-water oil production and exploration

2. Big distances in the sea and invisibility of sea operations

- Development of remote control systems and interventions by distance (ROV) to operations of assembly, removals and repairs of equipment installed in either seabed and well heads;

- Development of flowlines, risers and equipment for water deep, able to support the pressure of the water column of up to 3,000 meters between the production platform and the seabed;

- Development of powerful pumping systems and oil-water-gas separation equipment to be installed in seabed;

- Innovations in logistical issues in order to adequate the transport of people, equipment, material, food, consumers and etc.. in the long distances between platforms and the seacoast.

The limit of divers is 300 m depth
Technological challenges in deep-water oil production and exploration

3. Contaminant elements (H2S and CO2) presented in the oil and density of hidrocarbons

- Obtainment of steel alloys, special steel and anticorrosive coatings for the construction of christmas trees, subsea pipelines, risers, gas export pipelines and other equipment;
- Development of high power pumps and respective electric driver (around 1.5 MW) for installation inside wells, in order to extract the heavy and viscous oil;
- Application of nanotechnology techniques in order to prevent and avoid bacterial corrosion in pipelines, wells and oil tanks (nanoparticles for coatings in tanks, pipelines and wells and nanosensors for control and corrosion inhibition in oil wells);
- Construction of floating platforms equipped with compact carbon dioxide (CO2) and natural gas (hydrocarbon) separation systems and then transport the of natural gas to terminals on land and reuse the CO2 to reinjection system to increase the recovery factor of the reserves.
Technological challenges in deep-water oil production and exploration

Enviroment conditions: climate, rocks, sea enviroment

Big distances: Platform – well
Platform – coast

Operations invisibilities

Contaminants (CO$_2$ & H$_2$S) and oil viscosity

Technological challengers

Research and development actions involving oil companies, universities, research centers, equipment and material suppliers

Technological Inovation

- New sismics techniques
- Thermal insulations
- New materials
- Horizontal wells

- ROV
- DP (dynamic position platform)
- Resistance risers
- Subsea equipment form pumping and separation

- ROV

- Capture and separation of CO$_2$ and H$_2$S
- Special alloy steels
- Nanomaterials
- Subsea pumps
TECHNIP IN BRAZIL
Technip in Brazil

- A long-standing presence since 1977
- 3,500 people
- Assets in the Region
  - Flexibras plant
  - Port of Açú plant*
  - Port of Angra logistic base
  - Macaé marine asset support base
  - 7 vessels (2 of which under construction)
- Main expertise
  - Deepwater Subsea developments

- Full range of services
  - Engineering & project management
  - Procurement – worldwide market review & analysis of material pricing trends
  - Manufacturing
  - Marine Operations

- Providing conceptual to full EPC turnkey services
Technip in Brazil - Key Resources

- **Engineering Center**
  - Rio de Janeiro
  - Conceptual to full turnkey
  - Engineering, Procurement, Construction, Commissioning and Installation services
  - R & D test centers

- **Logistic Bases**
  - Flexibras in Vitória
  - Offshore Logistics in Macaé
  - Port of Angra

- **Marine Assets**
  - Sunrise 2000 (pipelay vessel)
  - Normand Progress (flexlay vessel)
  - Skandi Vitoria (pipelay vessel)
  - Skandi Niteroi (pipelay vessel)
  - Deep Constructor (flexlay vessel)
  - Twin 550t PLSVs* (flexlay vessels)
  - 4 Supply Boats
  - Fleet of ROV (Remote Operated Vehicle)

- **Manufacturing Plant**
  - Flexibras: Vitoria flexible pipe plant
  - Port of Açu*: High-end flexible manufacturing plant

* Under Construction
Key References in Brazil

- **1977 – Garoupa**
  - Platform and Subsea installation for Petrobras
- **1987 - Marlim Sul**
  - Subsea installation for Petrobras
- **2003 – P-52**
  - Semi-submersible platform for Petrobras
- **2004 – P-51**
  - Semi-submersible platform for Petrobras
- **2005 – PDET Project**
  - Subsea installation for Petrobras
- **2007 - Roncador**
  - 1,800 m water depth
- **2008 – Canapu Project**
  - First Pipe-in-Pipe in Brazil
- **2009 – P-56**
  - Semi-submersible platform for Petrobras
- **2010 – Skandi Vitória**
  - 1st Brazilian flag installation vessel
- **2011 – Skandi Niteroi**
  - 2nd Brazilian flag installation vessel
Technip in Region A / AFRICA

- Long-lasting presence since 1958
- A regular workforce of more than 7,200 people
- Headquarters: Paris la Défense (France)
- Associated centers in Western Europe, Africa and India
- Assets:
  - Dande Spoolbase (Angola)
  - Port Harcourt Logistics base (Nigeria)
  - Lobito Umbilicals factory (Angola)
- Strong expertise in the 3 segments
  - Subsea
  - Offshore
  - Onshore
Key References for Region A

**SUBSEA**
- **2003** – Subsea umbilicals, risers and flowlines ("SURF") package for the *Dalia* Project, offshore Angola.
- **2004** – Development of the *Greater Plutonio* field, located offshore Angola in Bloc 18, between 1,200 and 1,500 m water depth.
- **2005** – EPCI contract for the *Agbami* field development, offshore Nigeria in 1,550m water depth.
- **2008** – Development of the *Pazflor* oil field, located offshore Angola in Block 17, at water depths reaching 1,200m

**OFFSHORE**
- **1986** – *Ekofisk*: Raising of 6 Platforms in the North Sea to Compensate Subsidence
- **2003** – Gas compression platform and associated facilities installed in the *East Area* field offshore Nigeria
- **2005** – FPSO for the *Akpo* field development, offshore Nigeria
- **2011** – FLNG facility that Shell will deploy at its *Prelude* gas field off the northwest coast of Australia.

**ONSHORE**
- **1961** – Arzew (Algeria) LNG Plant
- **1973** – Liaoyang (China) Petrochemical complex
- **1980** – Omsk (former USSR) Aromatics Complex
- **1994** – Leuna (Germany) Grassroots refinery
- **2002** – 10th Olefins Complex (Iran) Cracking Plant
- **2004/2005** – 3LNG Mega projects in Qatar
- **2006** – Koniambo (New Caledonia) Nickel Smelter
- **2009** – SHARQ (Saudi Arabia) Ethylene Plant
- **2009** – Hassi Messaoud (Algeria) LPG project
- **2000** – Moerdijk (Holland) Ethylene Expansion
Key projects developed in South Atlantic
Pazflor (Angola)

- Client: Total
- Water depth: 1,200 m
- EPC Project: risers, flowlines and umbilicals
- Value > $1.7 billion
- Installation started in 2010

The largest Subsea contract ever, Technip share > $1.1 billion, High level of local content
KAOMBO (Angola)

- Client: Total
- Water depth: 2,000 m
- The contract covers the engineering, procurement, and fabrication of 120 km (75 mi) of umbilicals.

$3.5 billion, distributed 55% to Technip and 45% to Heerema.
Jubilee (Ghana)

- The first offshore field in Ghana
- Engineering, Fabrication and Installation projects involving Technip’s centers in Paris, Houston and Angola
- Fabrication of flexible pipes in Le Trait, France
- Mobilization of Deep Blue and Deep Pioneer for offshore campaign

An Example of a Seamless Project Execution

Multi vessel installation (Incl. Deep Blue/ Deep Pioneer)
Akpo FPSO* (Nigeria)

- Client: Total
- Water depth: 1,325 m
- Production capacity: 185,000 barrels/day
- Value: $ 1,080 million
- Execution: Technip / Hyundai
- First oil: March 2009

* FPSO: Floating Production Storage & Offloading Unit
Flexible Pipe Frame Agreement (Brazil)

- Client: Petrobras
- Value: $2.1 billion (of which 50% are guaranteed orders)
- Supply of ~ 1,400 km of flexible pipes
  - >150 types & diameters of risers, flowlines & associated equipment
- Supply starting in 2013
- To be produced at Technip's existing manufacturing site in Vitória, and new manufacturing facility under construction in Açu, Brazil

This frame agreement reinforces our leadership in flexible pipes and the subsea industry overall
**Tupi (Brazil)**

- **Client:** Petrobras
- **Location:** Santos Basin, Offshore Brazil
- **Water depth:** 170 m – 2,117 m
- **EPCI contract for 18” gas export pipeline with 216 km connecting Tupi FPSO to Mexilhão platform**
- **Pipeline installation method:** S-Lay
- **Offshore installation campaign by Solitaire (Allseas), Deep Constructor & Skandi Achiever (Technip)**

1st pre-salt gas exportation pipeline
P-56 Semi-submersible (Brazil)

- Client: Petrobras
- Consortium with Keppel Fels (FSTP)
- EPC for Semi-submersible FPU – W.D. 1,700 m
- Capacity: 180,000 bopd – gas: 6 million m³/day
- 32,000 tons Topsides
- Value: approx. $ 1,2 billion
- Year / Duration: 2007 - 2011

One of the largest semi-submersible platforms in the world
P-58 and P-62 FPSOs (Brazil)

- **Client:** Petrobras Netherlands B.v. (PNBV)
- **FEED and Detailed Engineering (hull and topsides) of 2 converted FPSOs, Procurement support and technical assistance to attend 5 Construction sites**
- **Capacity:** 180,000 bopd
- **Contract Value:** approx. $120 million
- **Year - Duration:** 2009 - 2013

Flagship Engineering service contract (1,5 million man-hours) demonstrating unique execution capability. Local content > 90%
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Thank you