Deep-water Pipelay
Having the right tools

what does it mean?

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Saipem
Objectives

• Advances in Deep-water Pipelay

• Can Deep water be EASIER than Shallow?

• Give a warm feeling that we are in control
Ultimate Comfort

Will your company entrust this gentleman with their precious deep-water projects?

No need: there is a handful of high quality contractors
Deep-water experience

In the last 12 years, Saipem has designed and installed 23 pipeline systems in water depths over 1,000 m.

Ultra-deep (in excess of 1,500 m water depth)

<table>
<thead>
<tr>
<th>PROJECT NAME</th>
<th>COUNTRY</th>
<th>CLIENT</th>
<th>LENGTH</th>
<th>DIAM.</th>
<th>WATER DEPTH</th>
<th>PERIOD</th>
</tr>
</thead>
<tbody>
<tr>
<td>BlueStream</td>
<td>Russia</td>
<td>Gazprom/SNAM</td>
<td>760 km</td>
<td>24&quot;</td>
<td>2,150 m</td>
<td>1999 - 2003</td>
</tr>
<tr>
<td>Canyon Express</td>
<td>USA</td>
<td>Elf</td>
<td>176 km</td>
<td>12&quot;</td>
<td>2,200 m</td>
<td>2000 - 2002</td>
</tr>
<tr>
<td>MEDGAZ</td>
<td>Algeria</td>
<td>Medgaz</td>
<td>210 km</td>
<td>24&quot;</td>
<td>2,155 m</td>
<td>2006 - 2009</td>
</tr>
<tr>
<td>P55 SCR and Flowlines</td>
<td>Brazil</td>
<td>Petrobras</td>
<td>75 km</td>
<td>12&quot;</td>
<td>1,900 m</td>
<td>2010 - 2013</td>
</tr>
<tr>
<td>JSM (Jack &amp; S. Malo)</td>
<td>USA</td>
<td>Chevron</td>
<td>226 km</td>
<td>24&quot;</td>
<td>2,140 m</td>
<td>2010 - 2013</td>
</tr>
<tr>
<td>Big Foot</td>
<td>USA</td>
<td>Enbridge</td>
<td>58 km</td>
<td>20&quot;</td>
<td>1,714 m</td>
<td>2011 - 2013</td>
</tr>
<tr>
<td>Guara - Lula NE</td>
<td>Brazil</td>
<td>Petrobras</td>
<td>76 km</td>
<td>18&quot;</td>
<td>2,130 m</td>
<td>2011 - 2013</td>
</tr>
<tr>
<td>Keathley Canyon Connector</td>
<td>USA</td>
<td>Williams</td>
<td>346 km</td>
<td>20&quot;</td>
<td>2,200 m</td>
<td>2011 - 2013</td>
</tr>
<tr>
<td>Lula NE - Cernambi</td>
<td>Brazil</td>
<td>Petrobras</td>
<td>19 km</td>
<td>18&quot;</td>
<td>2,232 m</td>
<td>2011 - 2014</td>
</tr>
<tr>
<td>Cabiunas Gas Export</td>
<td>Brazil</td>
<td>Petrobras</td>
<td>380 km</td>
<td>24&quot;</td>
<td>2,230 m</td>
<td>2012 - 2014</td>
</tr>
</tbody>
</table>
Pipeline Design

A subsea pipeline must do two fundamental things:
- Keep sea water **out**
- Keep Oil/Gas **in**

Initially, during installation, the pipe will be empty and the pressure will come from outside.

In operation, internal pressure from Oil/Gas can be much higher.

Outside pressure in 2500 metres water depth is 250 bar

Product pressure could be as high as 600 bar
Design Codes

International codes for the design of Pipelines have evolved greatly and have now been verified by extensive experience.

Two cases in point:

THE CURRENT STANDARD
• DNV OS-F101 ‘Offshore Standard for Submarine Pipeline Systems’
  • acceptance criteria and design procedures for pipelines.
  • applies modern limit-state-design principles

THE INNOVATION
• DNV “X-Stream”
  • A smart concept based on taking advantage of differential pressure to reduce pipe wall thickness
  • Will allow larger pipelines in deepewater to be deployed by existing equipment
Sea Current

Current and waves intensity decreases with depth.

Once below a certain depth, wave and current actions on the pipe are very limited.

In this example, the current at 200m water depth is 4 times stronger than at 2000m water depth.
S-Lay and J-Lay systems
J-Lay: perfect for deep-water
CastorOne: S-Lay and J-Lay together
S7000: Crane Vessel with J-Lay System
FDS & FDS2: Specialized J-Lay Vessels
J-Lay Tower: details
Step 1: the pipe is held by the J-Lay tower lower & fixed Clamp;

Step 2: a new QJ is transferred into the J-Lay tower by the loading arm;

Step 3: QJ alignment welding, NDT & FJC activities are completed;

Step 4: load is transferred to travelling Clamp and fixed Clamp is disengaged;

Step 5: the QJ is laid by simultaneously moving the vessel ahead and lowering the travelling clamp;

Step 6: load is transferred to fixed Clamp and a new cycle can start.
Vessel Position Tolerance

2,100m water depth: large allowable movements

300m water depth: tight position tolerance

Source: Saipem Blue Stream Pipelay
Vessel Position Tolerance

Allowable Vessel Position – 2,150m depth

Source: Saipem Blue Stream Pipelay
Vessel Position Tolerance

Allowable Vessel Position – 250m depth

Source: Saipem Blue Stream Pipelay
Offshore Pipeline Welding

Recent advances in Automatic Welding (GMAW) for offshore pipe-lay vessels. Noticeably:

- all positions welding
- exotic materials alloys (CRA and CLAD)
- Automatic Non-Destructive Testing (AUT) based on Ultra-sonic techniques
And what if it all goes wrong?

Some recent high visibility pipeline accidents (last 5 years only):

- 36” CATS trunk line
- 30” Kvitebjorn line
- 2 off 24” North Africa lines
- 30” ADMA Oil export line
- 20” & 26” TransMed trunklines
TransMed (TMPC) 26” and 20”

There are generally only 3 possible pipe damage scenarios:

- Minor leak or structural damage
- Dry buckle or kink
- Rupture
TransMed (TMPC) 26” and 20”
December 2008
Emergency Repairs: Reactive vs. Planned

**Emergency repairs: REACTIVE**

<table>
<thead>
<tr>
<th>Accident</th>
<th>Time to Repair</th>
<th>Mitigation <em>(or... the luck factor)</em></th>
</tr>
</thead>
<tbody>
<tr>
<td>CATS</td>
<td>6 months</td>
<td>Pipe was not ruptured – only kinked</td>
</tr>
<tr>
<td>TransMed</td>
<td>7 months</td>
<td>Shallow water damage, diver intervention</td>
</tr>
</tbody>
</table>

An unprepared pipeline repair in deep-water for a serious rupture could take up to 2 years *(engineering, procurement, manufacturing, testing, commissioning, operations)*

**Emergency repairs: PLANNED**

<table>
<thead>
<tr>
<th>System</th>
<th>Features</th>
<th>Time to Deploy</th>
<th>Time to Repair</th>
</tr>
</thead>
<tbody>
<tr>
<td>MedGaz</td>
<td>All components ready and maintained; procedures in place</td>
<td>48 hrs <em>(estimated)</em></td>
<td>7 to 10 days <em>(estimated)</em></td>
</tr>
</tbody>
</table>

**Let’s do the math** *(for MedGaz, approximately)*:

<table>
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<th>Gas transport capacity</th>
<th>Henry Hub Gas Price (31.08.2012)</th>
<th>Daily Losses</th>
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<td>20 million cubic meters per day</td>
<td>101 USD / thousand cubic meters</td>
<td>2 million USD / day</td>
</tr>
</tbody>
</table>
SIRCOS: Deepwater Pipeline Repair System

Intervention Equipment - Reusable

Specific Components - Permanent
Proven Technology

SIRCOS is qualified and already in operation

- **Qualified by DNV:**
  - The connection technology has a Type Approval Certificate covering applications for water depth up to 2,200 m

- **Two Systems in Operation in the Mediterranean:**
  - GreenStream (GSBV) - 32”dia, 1200 m w.d.
  - Medgaz - 24”dia, 2200 m w.d.

- **One System under build in the Middle East:**
  - Dolphin Gas Pipeline – 36” & 48”dia, 60 m w.d.
To conclude:

I have tried to scare you:

I have tried to re-assure you:

In Saipem, our money is on the bet that the industry will rest ASSURED (and INSURED!)