Successful Reliability & Safety with DP Vessels in the FPSO World

Part II
Typical Oil Company Requirements, Industry Precedents
Conclusions & The Way Forward

Peter Lovie  PE, PMP, FRINA
Successful Reliability & Safety with DP Vessels in the FPSO World

Part I - Monday 28 September 2009

DP Technology - Kongsberg

Standards & Regulatory Considerations - DNV

HiLoad DP System with Conventional Tankers

Part II - Wednesday 30 September 2009

Typical Oil Company Requirements

Industry Precedents

Conclusions & Path Forward
Today’s Agenda

Typical Oil Company Requirements
  How this session came about
  Operating risks of single and multiple wells;
  Multiple riser operations;
  Major storm and disconnection;
  Offloading considerations.

Industry Precedents
  Drillships, Shuttle Tankers and FPSOs

Conclusions
  Technical and Commercial

Path Forward
Steel and the first expansions, It paid, I tell you it paid,
When we came with our nine knot freighters and collared the long-run trade!
And they asked me how I did it, and I gave them the Scripture text,
“You keep your light so shining a little in front o’ the next!”
They copied all they could follow, but they couldn’t copy my mind,
And I left then sweating and stealing a year and a half behind.

Rudyard Kipling: from The “Mary Gloster”, a poem written in 1894 about a shipowner using technology to compete in world trade more than a century ago.
1. What an Oil Company May Want to Achieve: Extended Well Test (EWT) or Early Production System (EPS)

a. For EWT service to produce 1-2 wells operation a contract minimum term of several months might be desirable for operator but contractor will traditionally look for say 3-4 years to amortize investment exposure;

b. For EPS service the operator might look for say 4-7 years service with say 4-6 wells, i.e. roughly comparable to the BW Pioneer contract at Cascade/ Chinook in GoM

c. Mobilizing to location without prior special and separate installation of moorings and risers is desirable;

d. Ability to offload to readily available export tankers, e.g. can an FPSO on DP handle the hawser loads of a conventional tanker?

e. Desirable to be able to change the length of time on location at and be able to redeploy as well results become apparent;
During 2005-2006 Partners in Ultra Deepwater Developments Weighed Learning More on New Areas

Producing from untested formations;

Risks huge for a new development.

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<th>Field Name</th>
<th>Operator &amp; Development Status in 2009</th>
<th>Partners</th>
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<td>Cascade</td>
<td>Petrobras operated: single FPSO for both fields: <em>BW Pioneer</em> comes on station mid 2010</td>
<td>Devon 50%, Petrobras 50%</td>
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<td>Chinook</td>
<td>Petrobras 66.67%, Total 33.33%</td>
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<td>Jack</td>
<td>Chevron operated, FEED contracted Aug 09, single semisubmersible to serve both fields</td>
<td>Chevron 50%, Devon 25%, StatoilHydro 25%</td>
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<td>St. Malo</td>
<td>Chevron 43.75%, Devon 22.5%, Petrobras 22.5%, StatoilHydro 6.25%, ENI 3.75%, ExxonMobil 1.25%</td>
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Different fields, not far apart;

Different operator philosophies.
a. Principle of testing production at one well - or more than one well - at formations where there was no experience: estimates of production per well were still in a far too large range;

b. EWT and EPS tried before in North Sea and Brazil - successful for Petrobras;

c. Post 2005 realization that FPSOs must be disconnectable in advance of hurricanes in GoM;

d. Different nearby developments with same dilemma, and yet quite different operator styles - Chevron and Petrobras;

e. Brainstorms needed - what could the contractors suggest?

f. Not a planned combined campaign but practically and informally multiple oil companies and contractors worked the problem.
a. Two separate teams of operators and their partners wrestled with somewhat similar requirements for DP FPSOs for ultra deepwater GoM: - 
   - Cascade/Chinook: Petrobras operator, Devon & Total partners 
   - Jack St. Malo: Chevron operator, Devon, StatoilHydro, Petrobras, ENI partners 

b. Multiple contractors contributed their ideas to the debate: - 
   - Bluewater, Teekay 
   - Sofec, SBM 

c. They started in 2005, worked through 2006 and reported on their work in the April 2007 in partner meetings; 

d. By that time some patterns and conclusions had become clear; 

e. And all this led to decisions being made on field development choices for GoM and helped educate the GoM regulators; 

f. Which may be instructive for today’s discussion!
Chevron and Petrobras Engineers, with Field Partners, Made Important Assessments

a. Using typical shuttle tanker and FPSO characteristics for GoM, limits could be derived on how quickly disconnections should happen;

b. Stiffness of mooring and risers and how they compared to DP performance could be calculated;

c. Economics, operations and risks for single and multiple well operations were debated;

d. Similarly, economics and performance of DP and light moored FPSO station keeping could be compared;

e. DeepStar meetings were valuable;

f. True collaboration of professionals facilitated as they were all in a single location (Houston).
a. We comment on their thinking here, but the full presentations from the Houston meeting of the FPSO Research Forum in April 2007 are available at [www.fpf.com](http://www.fpf.com). Presentations from prior and subsequent meetings of the FPSO Research Forum may also be found (follow instructions on the website for access privileges);

b. Recognitions:

<table>
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<th>Key Presentations at FPSO Research Forum, Houston, April 2007</th>
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<tr>
<td>Author</td>
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<tr>
<td>Paulo Ferreira, Nick Howard</td>
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<td>Carlos Mastrangelo, Jeremiah Daniel</td>
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Basis for Analyses on DP FPSOs for GoM

a. Several Dynamic Positioning (DP) vessel simulation studies performed to dimension the DP system and turret disconnection system for an FPSO for the GoM;

b. FPSO needs to be disconnectable in advance of a Hurricane;

c. Station keeping for FPSO achieved with a DP system

d. Offloading to shuttle tanker in tandem;

e. Shuttle tanker could be DP or non DP;

f. DP must be capable of long term operations without downtime.

Source: Ferreira/Howard presentation, FRF, April 2007
Sensitivity - or Lack of - DP System to Turret Buoy/Riser Mooring Configurations

Source: Ferreira/Howard presentation, FRF, April 2007

- Nominal mooring system
  - provided by Technip (Orcflex data)

Difference of power consumption and positioning errors smaller than 0.5%!

“Light” mooring system 5 times softer than nominal

“Rigid” mooring system 5 times more rigid than nominal
Conclusions from DP Simulations

a. The proposed DP arrangement for the FPSO is capable of keeping position under all expected weather conditions without loop current;

b. The turret system should disconnect in under 3 minutes;

c. Operability data established for the crude shuttle tanker;

d. More work is needed on the loop current issue, as the FPSO needs to change heading at loop current limits (>2.3 kts).

Source: Ferreira/Howard presentation, FRF, April 2007
a. Risk of loss of one well during disconnection - a possibility, no one wants - still acceptable risk in EWT;

b. Loss of multiple wells during a fast disconnection for loss of DP is not a risk anyone wants to take. Hence the risk of disconnection of multiple risers is usually a deal killer and DP on EPS is unacceptable;

c. Up front demonstration of regulatory acceptability needed for an unusual EWT or EPS operation;

d. Must try to contain scope creep, to adhere to project target economics, i.e. simple EWT stays that way!

e. Tough to avoid design by committee to be able to do everything that is nice to have;

f. If we fail to stick to initial EWT or EPS scopes, we risk construction of the dreaded oilfield morphadite!
Instructive Example: Helix Producer
DP Floating Production Unit (FPU) - GoM in 2010

Comments:
- No storage, pipeline export;
- Note multiple risers with rapid disconnection system;
- Helix Energy Solutions contracts with Helix field operating division;
- Regulatory attention rigorous!

Source for image: Helix
Today’s Agenda

Typical Oil Company Requirements
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Industry Precedents
- Drillships, Shuttle Tankers and FPSOs

Conclusions
- Technical and Commercial

Path Forward
2. Industry Precedents

a. DP Drillships:
   Broad experience, similar hull sizes now, different service;

b. DP Shuttle tankers:
   Broad experience, many tankers of typical FPSO sizes;

c. DP FPSOs:
   Limited experience.
Drillship Precedent

a. Hull size - essentially Aframax - comparable to FPSO service;

b. Drillship designed to operate in (say) 200 to 3,000 meter water depth during contracts its design life, i.e. big range with big range of watch circle requirement, versus EWT at fewer locations, generally in ultra deep water, e.g. (say) 2,000 m. w.d.;

c. DP stationkeeping has to be provided to be operable in a wide range of environments, e.g. benign to harsh;

d. Well conditions generally unknown in advance for drillship versus EWT with known and fairly steady production. Must be able to deal with unexpected well situations and stay on station with a live well where reservoir conditions are not well known;

e. Design envelope for a drillship is different from that for an EWT vessel on a given location for many months - even years - and on a well with fairly well known pressures and flow rates;
Fitness for Purpose: Safety, Economy, Risks:
Compare a DP2 EWT or EPS with a DP3 Drillship

a. While the technical performance of drillships definitely shows that DP can function well for an FPSO size of hull, it is achieved with stringent specification and large investments to allow: (i) use of DP3, and (ii) capability for wide ranges of conditions;

b. Conclusions:

i. Multiple operating differences between drillship requirements and these for a DP FPSO may show how DP2 is adequate for EWT (certainly with Seillean experience);

ii. Safety is obviously paramount, question of careful analyses to avoid establishing precedents that are not necessary;

ii. Operators look for lower investment in an EWT vessel than a drillship.
Another Instructive Example:
MPF - Extra Large Drillship with FPSO Capability

Multi Purpose Floater
Unusual Combination of Capabilities, Options

**Basic Floater Configuration**
Full DP/Thruster Positioning System - Class 3
Port and starboard escape tunnels, LQ and deck cranes
1 Million Barrels Storage, and offloading equipment
(aft and forward) Drilling and Early Production

**Early production package;**
drilling, storage and offloading capability
6th generation drilling package
Multiple production risers

**FPSO**
Production facilities for up to 200,000 bbls/day oil/cond, oil storage and
offloading capability
Multiple production risers

**MultiPurpose Floater**
Simultaneous drilling, production, storage and oil offloading capability
6th generation drilling package
Multiple production risers

Source: MPF
Technically Doable, Commercially Questionable

a. Unusually large hull size (Suezmax), sixth generation drilling package, DP3 designed to cope with for harsh environments, two moonpools;

b. Interesting potential for drilling one deep well in GoM while testing another. But lining up a drilling and appraisal program very difficult to achieve and operators reluctant to pay the premium for a combined 6th generation drillship with test capability;

c. Drillships with limited storage for test production do sometimes see combined function but not often - or for much beyond weeks;

d. The risk remained of quickly disconnecting both a drilling riser and a production riser - or multiple production risers - in the event of a drive off;

e. Difficulties in project completion, killed in the financial meltdown of 2008;

f. No one questioned the ability of MPF to work as a DP FPSO.
Industry Precedent - Shuttle Tankers - the World Fleet

a. Currently 72 shuttle tankers (8.4 millions tons DWT) in service compared to 6,900 oil tankers and 3,600 chemical tankers;

b. Average age of shuttle tanker fleet is 10.8 years;

c. By 2012, 11 more shuttle tankers (0.9 million dwt) will be delivered

Shuttle tankers serve more than 40 oil fields totaling more than 1,500 liftings per year (4+ liftings per day)

Source: Lloyd’s Register Fairplay 2007 and DNV
A State of the Art DP Tanker

Source: Kongsberg
Shuttle Tanker Similar to a Conventional Tanker with a Few Exceptions

Additional crew

Bow Loading system (BLS)

DP2: CP propeller & high lift rudder

Structural enhancement, Increased ballast capacity & Enhanced fire protection

DP2: Azimuth & tunnel thrusters

The main difference being the Dynamic Positioning system and customized Bow Loading system

Source: DNV
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Source: DNV
History of Good Industry Collaboration on DP Performance

DP 2000 Joint Industry Project (JIP)

KONGSBERG

Chevron

NTNU

STATOIL

HESS

GLOBAL MARITIME A/S

MARINE, OFFSHORE AND ENGINEERING CONSULTANTS

Singapore

29-30 September 2009

IQPC 10th Annual FPSO Congress
Conclusions on Shuttle Tanker Operation on DP

a. History of DP shuttle tankers being a routine operation, widely accepted, initially in North Sea and now in Brazil;

b. Service often in harsh environments with large vessels, e.g. Suezmax common;

c. Penalty to the operator for adverse performance is extreme - spilling oil! Seems to concentrate the mind of everyone;

d. Regulatory framework works, steadily progresses;

e. Adaptation of a DP shuttle tanker practices to EWT service therefore does not appear to be any leap of faith!
# The World's Dynamically Positioned FPSOs

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<th>Unit Name</th>
<th>Lease/Own</th>
<th>Field Operator</th>
<th>Floater Owner</th>
<th>Storage Capacity, mbbl</th>
<th>Install Date</th>
<th>Water Depth, meters</th>
<th>Processing Capability</th>
<th>Station Keeping</th>
</tr>
</thead>
<tbody>
<tr>
<td>Marlim Leste</td>
<td>Brazil</td>
<td>Seilean</td>
<td>Lease</td>
<td>Petrobras</td>
<td>Frontier</td>
<td>310</td>
<td>2006</td>
<td>1,100</td>
<td>23,500 b/d oil</td>
<td>Dynamic positioning</td>
</tr>
<tr>
<td>Galoc</td>
<td>Philippines</td>
<td>Rubicon Intrepid</td>
<td>Lease</td>
<td>Galoc Production</td>
<td>Rubicon Offshore</td>
<td>450</td>
<td>2007 (start up 8/08)</td>
<td>290</td>
<td>25,000 b/d oil</td>
<td>DP assist</td>
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<tr>
<td>BMG</td>
<td>Australia</td>
<td>Crystal Ocean</td>
<td>Lease</td>
<td>Roc Oil</td>
<td>Sea Production</td>
<td>42</td>
<td>2005</td>
<td>150</td>
<td>40,000 b/d oil</td>
<td>Dynamic positioning</td>
</tr>
<tr>
<td>Various GOM fields</td>
<td>Mexico</td>
<td>Bourbon Opale (well test/service)</td>
<td>Lease</td>
<td>Pemex</td>
<td>Bourbon</td>
<td>11</td>
<td>2004</td>
<td>n.a.</td>
<td>15,000 b/d oil</td>
<td>Dynamic positioning</td>
</tr>
<tr>
<td>Various GOM fields</td>
<td>Mexico</td>
<td>Toisa Pisces (well test/service)</td>
<td>Lease</td>
<td>Pemex</td>
<td>SeaLion</td>
<td>24</td>
<td>2003</td>
<td>n.a.</td>
<td>20,000 b/d oil</td>
<td>Dynamic positioning</td>
</tr>
<tr>
<td>Available</td>
<td>TBD</td>
<td>BW Carmen (temp. use as APTV)</td>
<td>Lease</td>
<td>TBD</td>
<td>BW Offshore</td>
<td>50</td>
<td>TBD</td>
<td>TBD</td>
<td>25,000 b/d oil</td>
<td>Dynamic positioning</td>
</tr>
<tr>
<td>Phoenix</td>
<td>US GoM</td>
<td>Helix Producer I</td>
<td>Lease</td>
<td>Helix Oil &amp; Gas</td>
<td>Helix Energy Solutions</td>
<td>0</td>
<td>2010</td>
<td>1,200</td>
<td>45,000 b/d of oil 72 MMcf/d gas</td>
<td>Dynamic positioning</td>
</tr>
<tr>
<td>TBD</td>
<td>Brazil</td>
<td>Dynamic Producer</td>
<td>Lease</td>
<td>Petrobras</td>
<td>Petroserv</td>
<td>300</td>
<td>2010</td>
<td>2,500</td>
<td>30,000 b/d oil</td>
<td>Dynamic positioning</td>
</tr>
</tbody>
</table>

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**In service at end of 2008**

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**Future service**

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The longest and most relevant experience is with *Seillean*, hence that is the basis of most of the analysis here.
A large offshore service vessel with DP3 and a process package on deck.
Operating Concept with Subsea Production: Crystal Ocean & Crystal Sea DP FPSOs

Shuttle-tanker DP

400 m

Crystal FPSO DP

Free-Standing Production Riser

800 m

2000 m
Crystal Sea on DP - EWT in Norwegian Sector

Similar operation to Crystal Ocean
Crystal Ocean - Example of Production on DP in UK Sector

Chestnut was an Amerada Hess operated field in the Northern Sector of the UK North Sea

*Crystal Ocean* successfully carried out approx. 120 days EWT July-December 2001 under severe weather conditions;

Produced 1.1 mmbbl oil, average uptime in excess of 95% (ex. approved downtime), no Lost Time Accidents, full DP operation;

Discharging to shuttle tanker, storage limitation successfully dealt with;

Project repeated in South Australia in late 2005.

Seillean Operated in Shallow Waters of North Sea for Nine (9) Years before Moving to Deep Waters of Brazil

As Seillean operated since 1999, this time continuously on station - normal cycle with export tankers being hawser moored or on DP.

As BP SWOPS, operated at several fields - unusual cycle of loading then delivery to refinery.
2,000 m water depth
Up to 24,000 bopd API 17-32
98% uptime (2004-2008)
10 Years of operation in Brazil
54 mmbbl crude oil produced

Dock independent thruster overhaul - increased availability
Upgraded Power Management system - improved efficiency
Next Dry-dock 2018 - following Lloyds Hull survey program
Seillean Summary Specification

Hull: 250.0 x 37.0 x 19.8m, draft 11.0m. Crude Oil Storage: 300,000 bbl, double sides, tanks and hull condition “good as new”!

Operating water depth: up to 2,000 meters;

Handling FMC 6-5/8” production riser and X3 - 10 Year proven;

Station keeping: Dynamic Positioning DP2;

Thrusters: 7 x 3 MW; Power: 3 Diesel Engines + 3 Gas Turbines - 22 MW utilizing produced gas for power and steam production;

Production Plant capacity: up to 24 000 bopd (proven) API 17 to 32 (proven);

Separate ROV moonpool;

Offloading in DP mode to Transpetro standard tankers (Aframax DP1);
## Downtime History - 1999-2008

<table>
<thead>
<tr>
<th>Year</th>
<th>Production</th>
<th>Standby</th>
<th>Downtime</th>
</tr>
</thead>
<tbody>
<tr>
<td>1999</td>
<td>94.0%</td>
<td>1.4%</td>
<td>4.6%</td>
</tr>
<tr>
<td>2000</td>
<td>98.1%</td>
<td>0.3%</td>
<td>1.6%</td>
</tr>
<tr>
<td>2001</td>
<td>83.0%</td>
<td>15.6%</td>
<td>1.4%</td>
</tr>
<tr>
<td>2002</td>
<td>58.1%</td>
<td>40.3%</td>
<td>1.7%</td>
</tr>
<tr>
<td>2003</td>
<td>96.8%</td>
<td>2.9%</td>
<td>0.3%</td>
</tr>
<tr>
<td>2004</td>
<td>67.3%</td>
<td>6.8%</td>
<td>25.9%*</td>
</tr>
<tr>
<td>2005</td>
<td>93.7%</td>
<td>5.8%</td>
<td>0.5%</td>
</tr>
<tr>
<td>2006</td>
<td>92.7%</td>
<td>7.2%</td>
<td>0.2%</td>
</tr>
<tr>
<td>2007</td>
<td>99.7%</td>
<td>0.2%</td>
<td>0.1%</td>
</tr>
<tr>
<td>2008</td>
<td>51.6%</td>
<td>0.1%</td>
<td>38.59%*</td>
</tr>
</tbody>
</table>

*Dry-docking in Rio
<table>
<thead>
<tr>
<th>Year</th>
<th>Nº</th>
<th>Reason</th>
</tr>
</thead>
<tbody>
<tr>
<td>1999</td>
<td>2</td>
<td>Failure on the tensioning cable / Failure on the HPU</td>
</tr>
<tr>
<td>2000</td>
<td>2</td>
<td>Problems with the DP System / Failure in the computer</td>
</tr>
<tr>
<td>2001</td>
<td>2</td>
<td>Failure on the PMS / Failure on the KOS panel</td>
</tr>
<tr>
<td>2002</td>
<td>2</td>
<td>Electrical problems during load power test</td>
</tr>
<tr>
<td>2002</td>
<td>2</td>
<td>Severe weather conditions / Human error when controlling the EDP</td>
</tr>
<tr>
<td>2003</td>
<td>1</td>
<td>Failure energy generation.</td>
</tr>
<tr>
<td>2004</td>
<td>0</td>
<td>None</td>
</tr>
<tr>
<td>2005</td>
<td>1</td>
<td>Electrical Problem on the PMS System.</td>
</tr>
<tr>
<td>2006</td>
<td>0</td>
<td>None</td>
</tr>
<tr>
<td>2007</td>
<td>1</td>
<td>Failure on the DGB governor</td>
</tr>
<tr>
<td>2008</td>
<td>0</td>
<td>None</td>
</tr>
<tr>
<td>2009</td>
<td>1</td>
<td>DP failure due to software error of new system.</td>
</tr>
</tbody>
</table>
Seillean as BP SWOPS in 1990

Tanker based design;
75 - 200m water depth;
Dynamically positioned;
1-2 subsea wells;
Single rigid riser and handling system;
Process system for 20,000 bopd;
Oil storage 320,000 bbls, transit to offload.
History as BP SWOPS

North Sea

1989  Delivered by Harland & Wolff for BP Shipping as a Single-well oil-production system (SWOPS) vessel for development of marginal fields.

1990  Vessel Construction Completed

1990  April - BP Cyrus Field (North Sea) until April 1992

1992  BP Donan Field (North Sea) until December 1997

1993  Acquired by Reading & Bates, who continued to operate the vessel for BP until 1997. In 1998 PETROBRAS started negotiations with R&B for the charter of the vessel as early production system (EPS) for the Roncador Field.

1998  Deep Water Conversion, January-November

1998  November, began a 6-year charter, mobilized to Brazil
History as Seillean DP2 FPSO

Brazil

1999  Operations as EPS started after upgrade work to allow operation in up to 2,000 m. water depth.

First oil at Roncador 25Jan99: four years at Roncador in 1,853 m. of water.

2001  Acquired by Frontier Drilling ASA (Norway) which was responsible for the last upgrade that enabled the vessel to process heavy crude up to API 13.

2003  Producing abt 20,000 bopd at Jubarte in 1,323 m. water depth, 13 deg API heavy oil with artificial lift.

2005  With the addition of the down times for dry-docking, termination of the contract will in December 2004 / January 2005, since been renewed.
Early History with Petrobras on EPS & EWT

a. From the beginning of its offshore production in the mid 70s, Petrobras has used Early Production Systems (EPS) as a way to increase oil production, accelerate project cash flow and acquire better reservoir and environmental data for the specification / construction of “definitive” production units;

b. For the development of the deep water fields of Marlin South and Roncador Petrobras introduced the concept of Extended Well Test (EWT), with same objectives of the EPS but with the difference that the EWT system should stay at a defined location for a limited time and be easily mobilized to the next location;

c. ANP (Brazilian Petroleum Agency) placed restrictions for EPS systems, mainly related to gas burning;

d. Comparison with other EWT vessel: for the Marlin South EWT campaign, Petrobras contracted in 1996 the FPSO II from SBM, which was basically a tanker with a 40,000 bopd process plant on deck, offloading station at the bow, moored by the stern via a yoke to a single point mooring buoy, able to be connected to up to two wells.
• May 14, 2003 Petrobras announces oil find in block BC-60 in Espirito Santo – water depth 1330 meters, estimated reserves 600 million barrels ("Cachalote")
• June 04, 2003 Petrobras announces four new oil field discoveries in the block BC-60 offshore Espirito Santo nearby the Jubarte and Cachalote fields – water depths between 1473 and 1535 meters, estimated reserves 630 million barrels
• July 11, 2003 Petrobras announces important discovery in Espirito Santo block BES 100 located 80 km from Vitoria – water depth 1374 meters
• October 2, 2003 Petrobras makes new discovery of light oil in block BC 60 - water depth 1824 meters

Petrobras’ internal task force study group has “scheduled” the Seillean as follows:
• Jubarte thru July 2005
• Cachalote July 2005 – October 2005
• Well “A” October 2005 – January 2006
• Well “B” January 2006 – July 2006
• Well “C” July 2006 – Jan 2007
Arrangement of Seillean at Roncador

Production from subsea well, simple to install
System design allows convenient economical mobilization to new Locations:-

a. Single drillpipe riser

b. Requires pipehandling, derrick and moon pool on tanker

c. Single well (or multiple wells manifolded)

d. Control umbilical strapped to riser

e. LMRP for riser disconnecting
2008 Upgrade

Class Notation: Next Drydocking 2018 - in-water surveys each 3 - 4 year since 2008 (Lloyds);

10 year paint system (Jotun). Special E-application in moon-pool;

Thrusters: Modified for under-water installation. 2 ea spare thrusters standby for exchange (Wartsila);

Power Managements System: New (Converteam) Dynamic Positioning System: New (Converteam);

Gas Turbines: Upgraded for improved efficiency

Accommodation: 85 beds;

50 m² handling & storage deck;

Result: operational life extended - expect further 15 to 20 years
Offloading Operations

Where export tankers have been hawser moored to *Seillean*, mooring loads were accommodated by the DP system on *Seillean*.

As at May 2008 *Seillean* has done over 300 successful offloading operations.
History Makes the Case for an DP FPSO as an EWT Tool

a. History with *Seillean* as a DP FPSO is a remarkable success story: with two leading oil companies (BP and Petrobras) in two quite different environments (shallow water North Sea and deepwater Brazil).

a. Successful operation at multiple deepwater fields;

b. Uptime as good as or better than non DP FPSOs;

c. Ability to offload from a DP FPSO to larger tankers has been well proven with 300+ liftings;

d. Disconnection due to DP related problems have been remarkably few and have been getting less. A manageable risk;

e. History is demonstrating a sound commercial business for both the operator (Petrobras) and the contractor (Frontier), has encouraged Petrobras to contract for another EWT vessel.
No storage

Note multiple risers with rapid disconnection system
In 2003 Petrobras started a study named PIPA (Early Production Integrated Planning) with the objective to define fields / discoveries that would justify the employment of EWT and EPS units. Bids were requested for PIPA 2: winner was Petroserv of Brazil, offering what is now known as *Dynamic Producer*

Generally similar to *Seillean* in function, but with enhanced well intervention capabilities.
Today’s Agenda - Wrapping Up

Typical Oil Company Requirements
- How this session came about
- Operating risks of single and multiple wells;
- Multiple riser operations;
- Major storm and disconnection;
- Offloading considerations.

Industry Precedents
- Drillships, Shuttle Tankers and FPSOs

Conclusions
- Technical and Commercial

Path Forward
3. Conclusions – Technical & Commercial

a. A DP2 FPSO has worked successfully for nine (9) years in the shallow waters and harsh environment of the North Sea, a particularly demanding location for a DP FPSO, and for the last ten (10) years in deep water offshore Brazil. So the concept of a FDP FPSO is reasonably well proven;

b. However that precedent with a single riser system in EWT service contrasts with the serious risk exposures in employing a DP FPSO with multiple risers where the small risk of DP drive off could cause a large loss of expensive multiple wells;

c. Deployment and retrieval of a single drillpipe riser has proven successful with Seillean. Other riser types and multiple riser systems may be more complex and expensive and represent a serious economic factor for weighing field deployments;

d. On the Cascade/Chinook EPS the economics and risks argued for a conventionally moored FPSO instead of a DP FPSO;

e. While the concept of EWT seems top make obvious sense, operator philosophy is a key factor in the decision to employ EWT, e.g. Petrobras in Brazil.
a. The path forward in the immediate term for DP FPSO is obvious, i.e. use of Dynamic Producer in Brazil;

b. Operating oil companies have long debated the need for EWT internally - is the high cost for information the obtained justifiable? Do we go forward with well estimates of P10 at 3,000 bopd and P90 at 12,000?

c. As the easy oil becomes more and more elusive, and deep wells become more and more expensive, obtaining that producibility information is more difficult and may be worth investing big bucks to obtain, cf. Jack well test in GoM, EPS at Cascade/Chinook;

d. Securing EWT business to justify investment in future DP FPSOs appears a niche market and yet time appears a to push oil companies with deep water acreage to increasingly consider EWT and the DP FPSO option;

e. The more field development planning driven EWT requirements would imply better margins for a DP FPSO with that market being relatively independent from the more production driven FPSO cycle that is currently subject to an unusually large number of idle FPSO.
Thank you

Questions?

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