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FPSO CONGRESS 2009

Successful Reliability & Safety with DP Vessels in the FPSO World

Part II

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

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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

We All Want to Use Technology to Compete in World Trade: But It's Not New!

Steel and the first expansions, It paid, I tell you it paid,

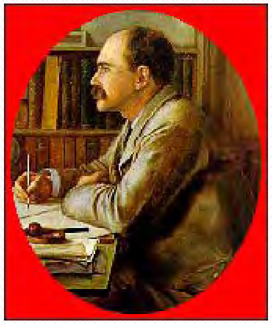
When we came with our nine knot freighters and collared the long-run trade!

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 <u>EWT service </u>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 <u>EPS service </u>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;

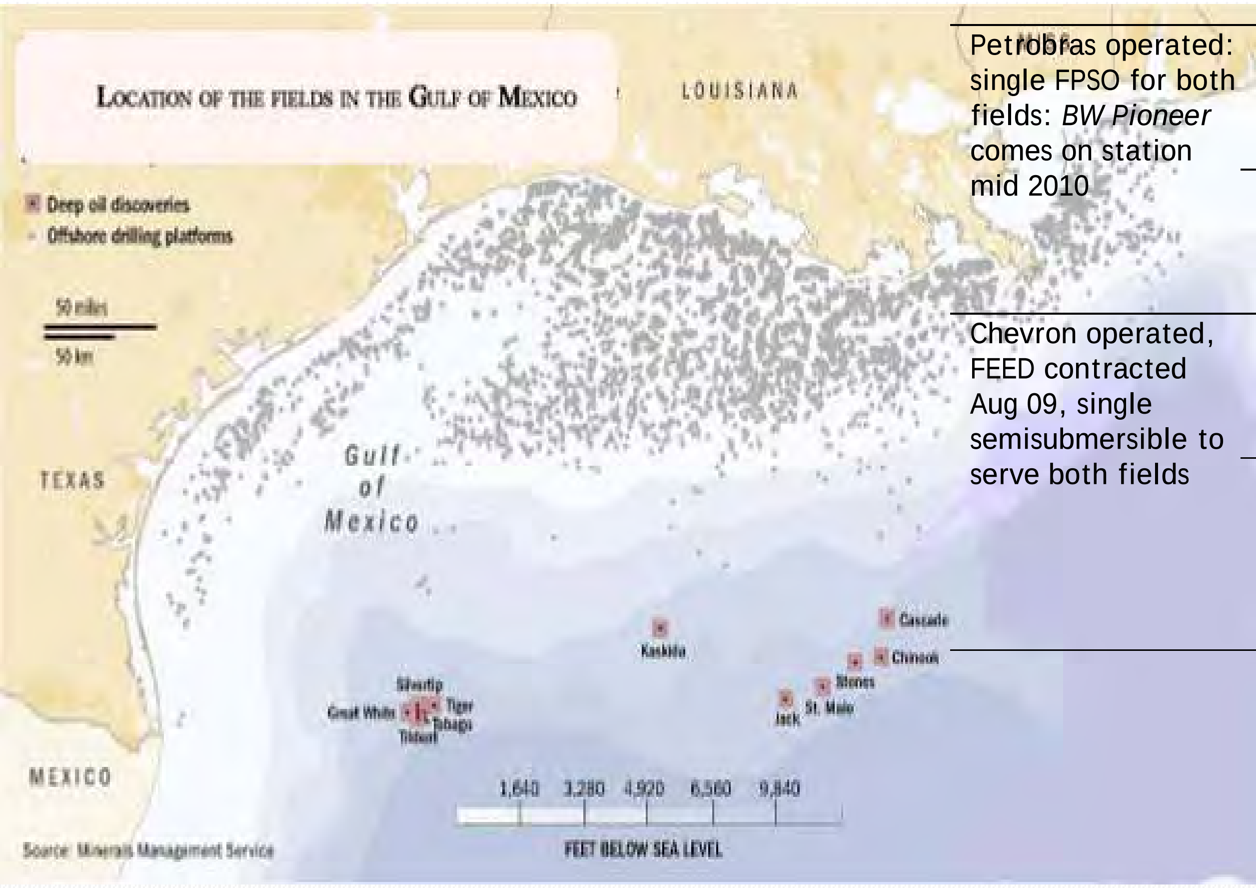
d. Ability to offload to readily available export tankers, e.g. can an FPSO on DP handle the hawser loads of a conventional tanker?

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.



Key Ultra DeepWater Fields in US GoM

Operator & Development Status in 2009	Field Name	Partners
Petrobras operated: single FPSO for both fields: *BW Pioneer* comes on station mid 2010	*Cascade*	Devon 50%, Petrobras 50%
	Chinook	Petrobras 66.67%, Total 33.33%
Chevron operated, FEED contracted Aug 09, single semisubmersible to serve both fields	*Jack*	Chevron 50%, Devon 25%, StatoilHydro 25%
	St. Malo	Chevron 43.75%, Devon 22.5%, Petrobras 22.5%, StatoilHydro 6.25%, ENI 3.75%, ExxonMobil 1.25%

Different fields, not far apart;

Different operator philosophies.

Ultradeep Lower Tertiary in GoM in 2005: Extended Well Test (EWT) or Early Production Systems (EPS) ?

a. Principle of testing production at one well - or more that 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.

Consideration of DP FPSOs for GoM

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).

FPSO Research Forum: Valuable Information Source

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 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:

Key Presentations at FPSO Research Forum, Houston, April 2007			
Author	Company	Presentation	Themes
Paulo Ferreira, Nick Howard	Chevron (now at Petrobras)	DP FPSO for GoM: Considerations for the FPSO and Shuttle Tanker	Results & Conclusions from DP Simulations
Carlos Mastrangelo, Jeremiah Daniel	Petrobras	US GoM EPS FPSO - Operators' Perspective	Disconnectable FPSOs

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;

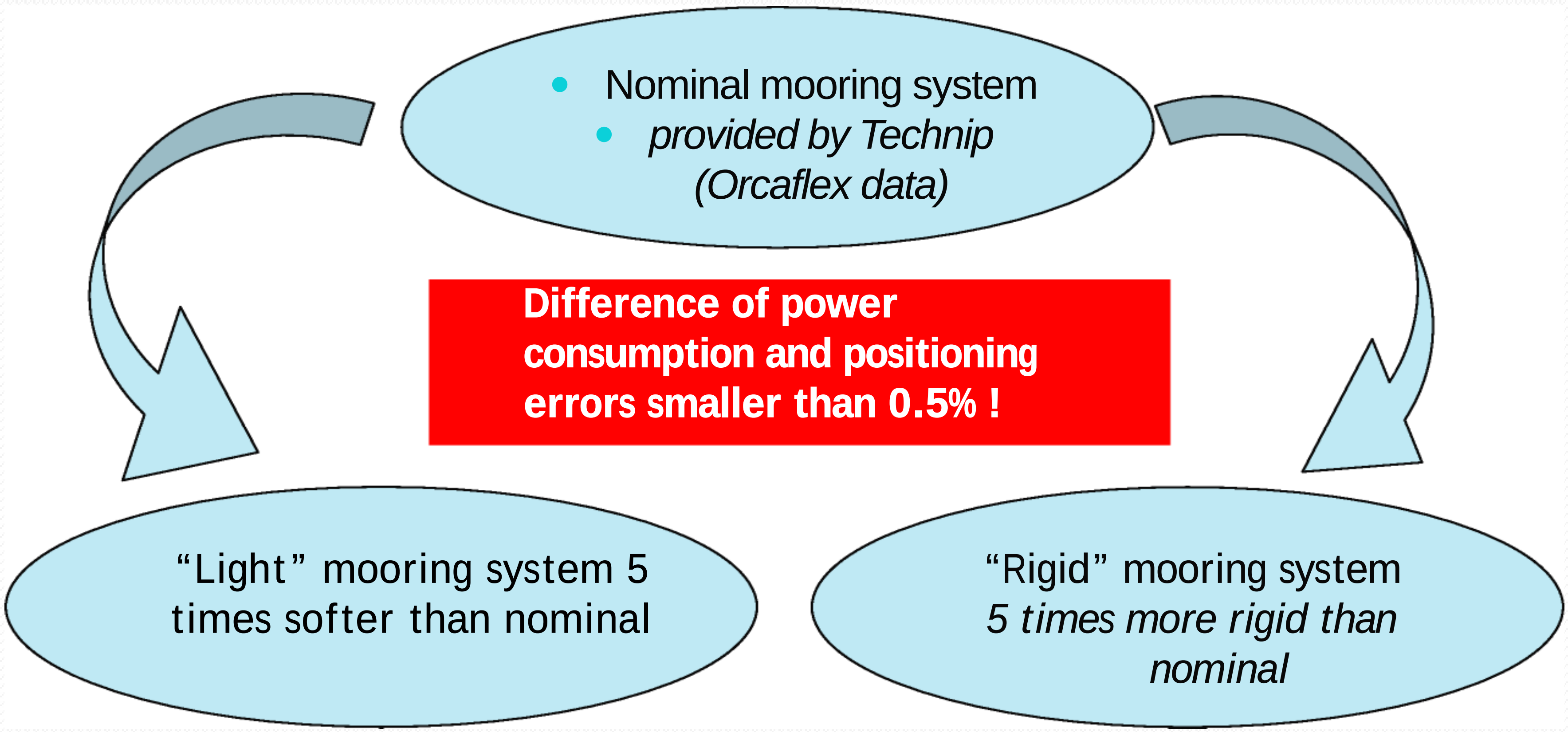
e. Shuttle tanker could be DP or non DP;

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



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

What Some of us Learned from the 2005-2007 Deliberations on DP FPSOs for GoM

a. Risk of loss of one well during disconnection - a possibility, no one wants – still acceptable risk in EWT;

b. Loss of <u>multiple</u> 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;

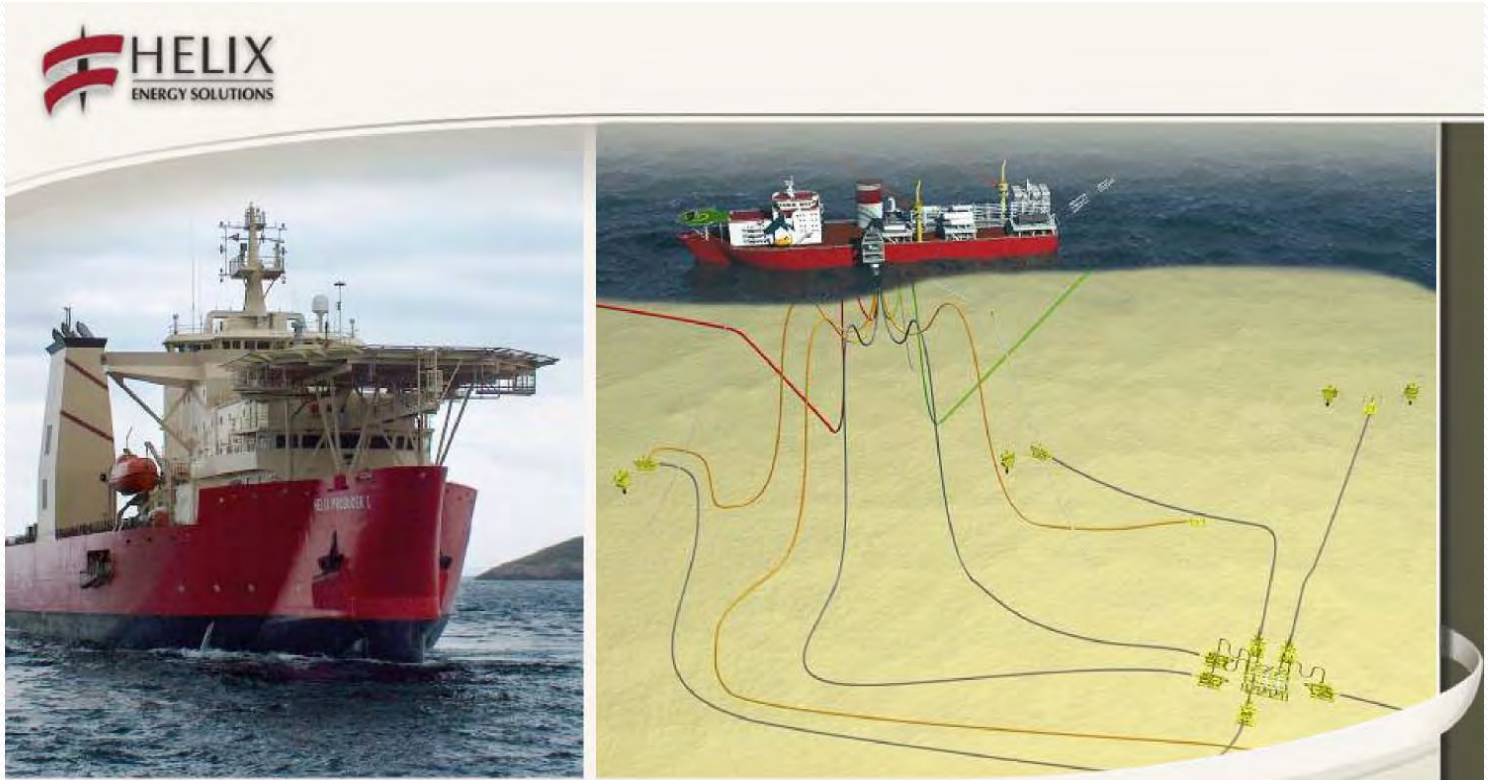
c. Up front demonstration of regulatory acceptability needed for an unusual EWT or EPS operation;

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



Source for image:
Helix

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

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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;

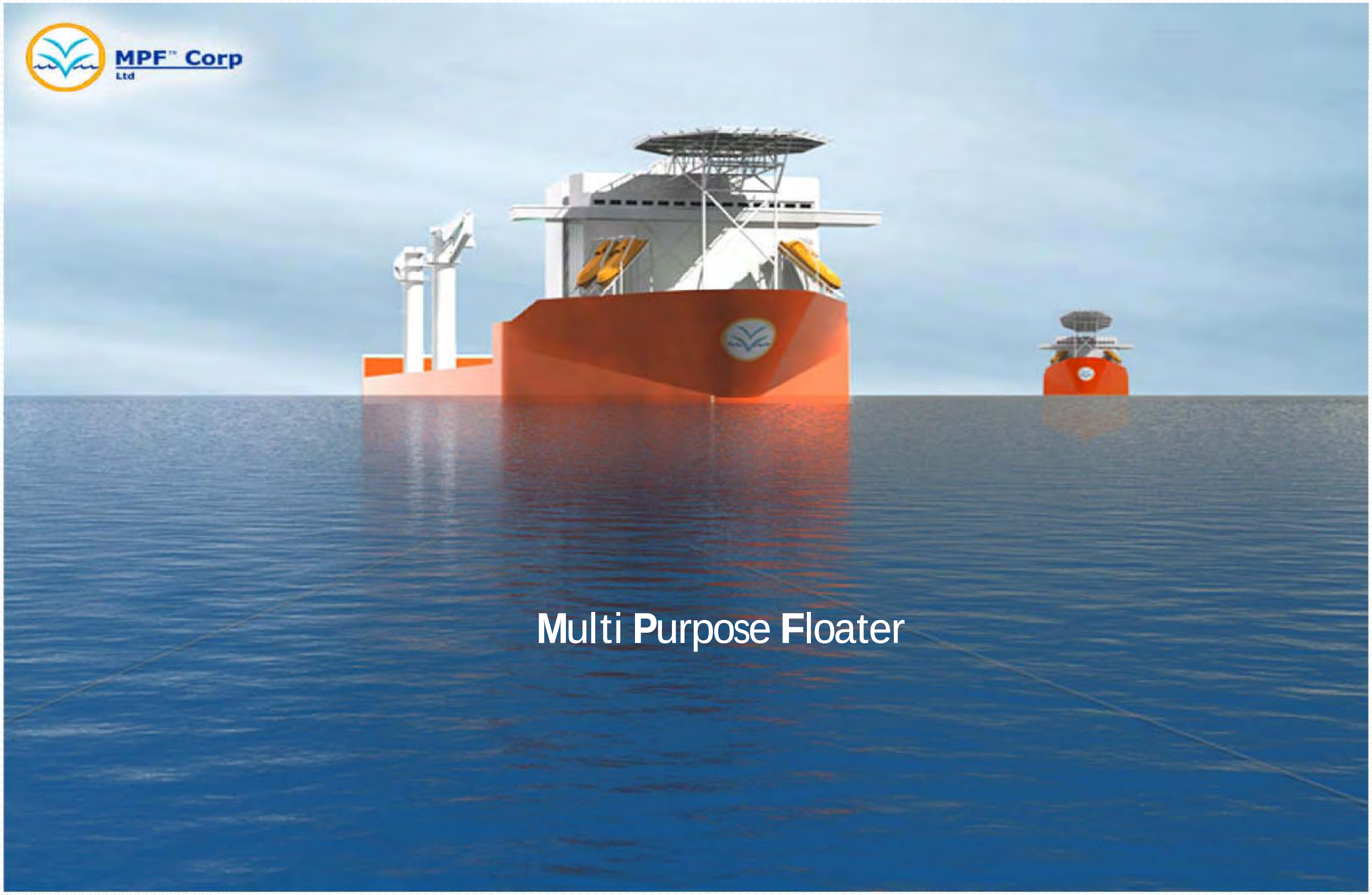
b. Conclusions:

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);

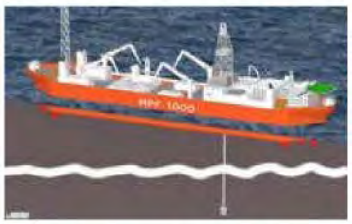
ii. Safety is obviously paramount, question of careful analyses to avoid establishing precedents that are not necessary;

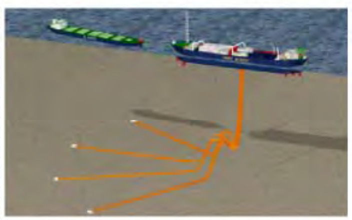
ii. Operators look for lower investment in an EWT vessel than a drillship.

Another Instructive Example:
MPF - Extra Large Drillship with FPSO Capability



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;

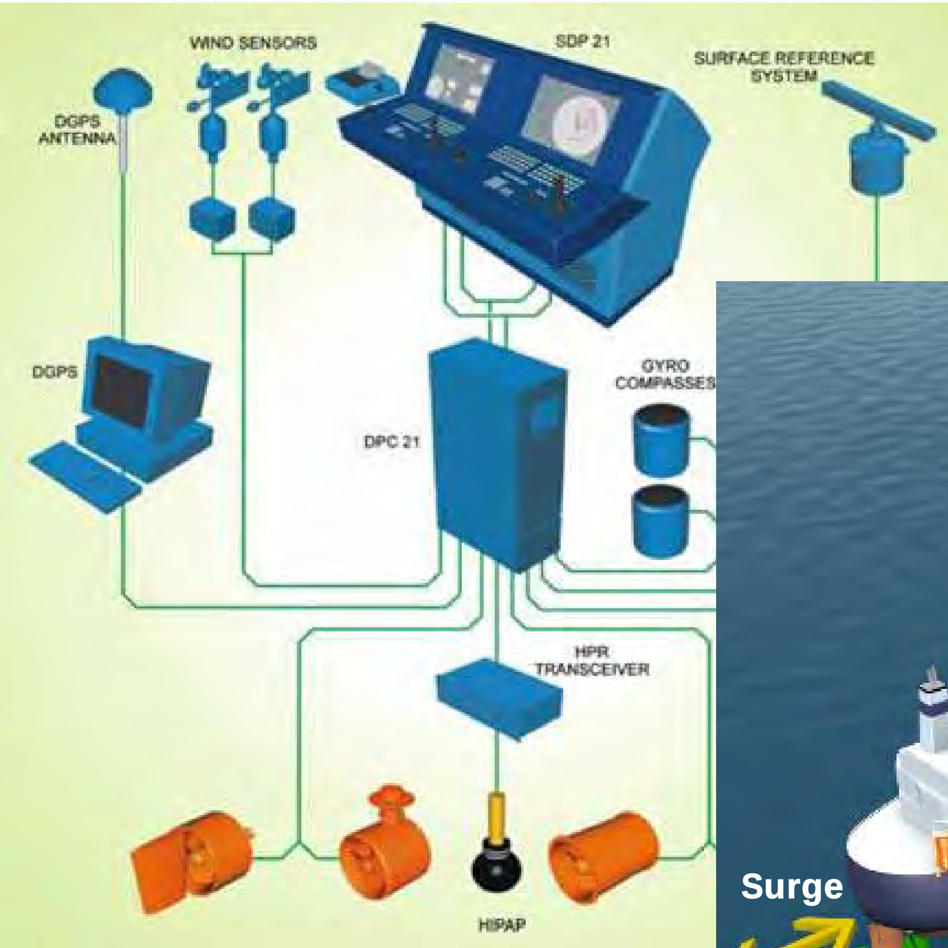
b. Average age of shuttle tanker fleet is 10.8 years;

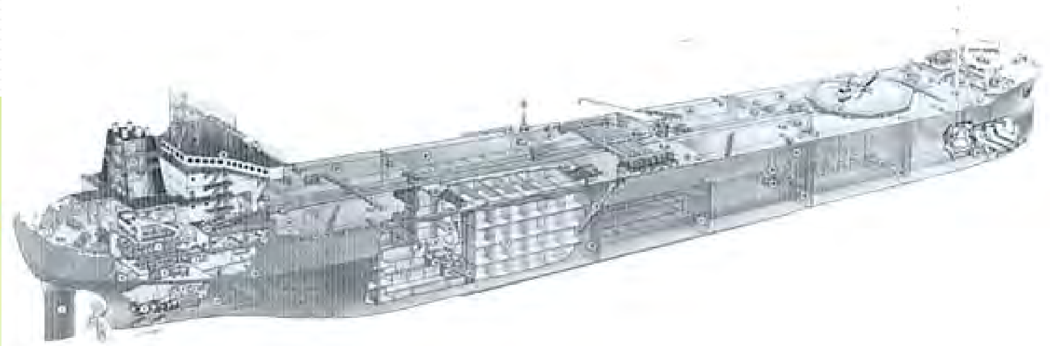
c. By 2012, 11 more shuttle tankers (0.9 million dwt) will be delivered

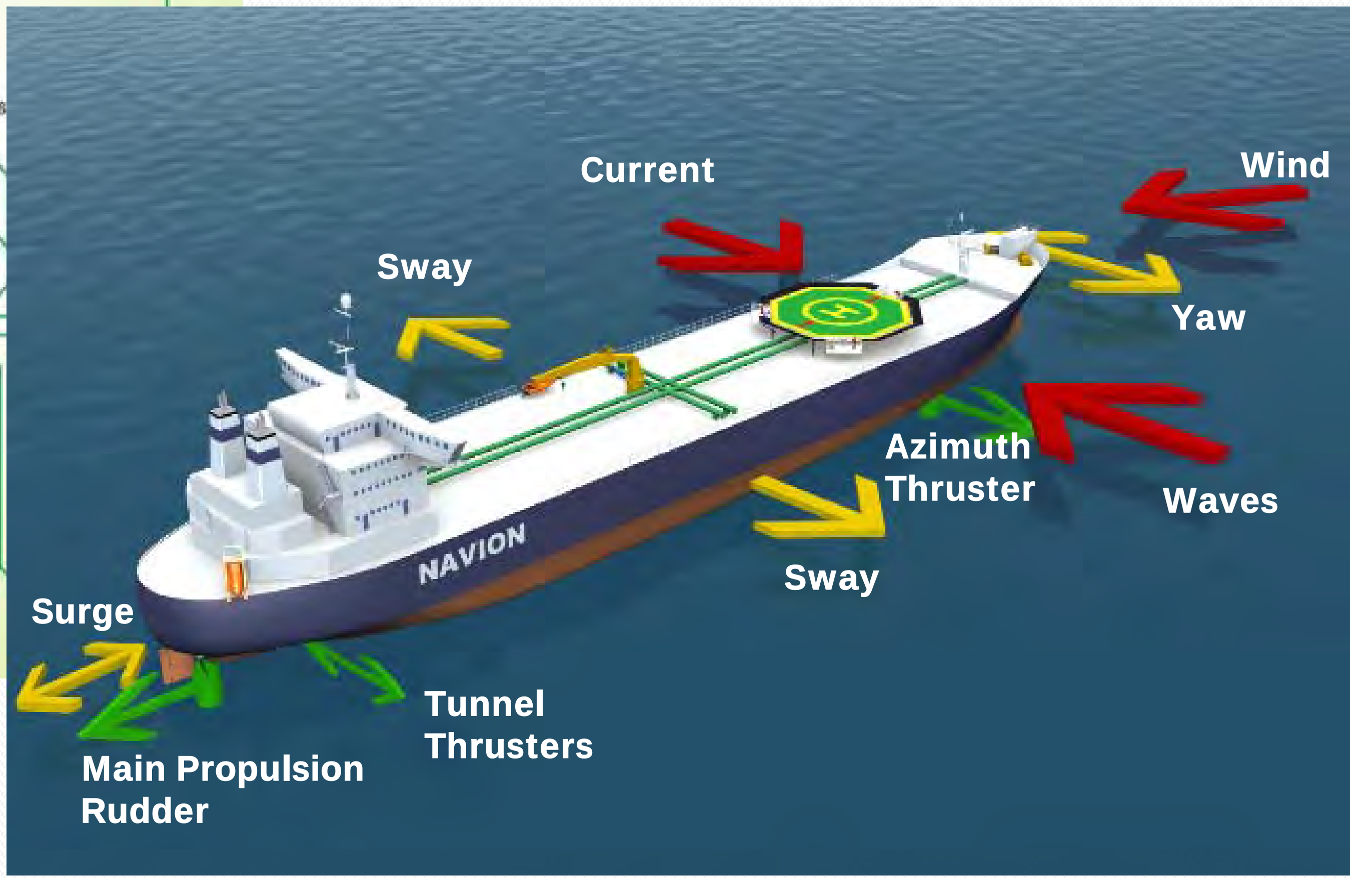
Shuttle tankers serve more than 40 oil fields totaling more than 1,500 liftings per year (4+ liftings per day)

Source: Lloyd’s Register Fairplay 2007 and DNV

A State of the Art DP Tanker

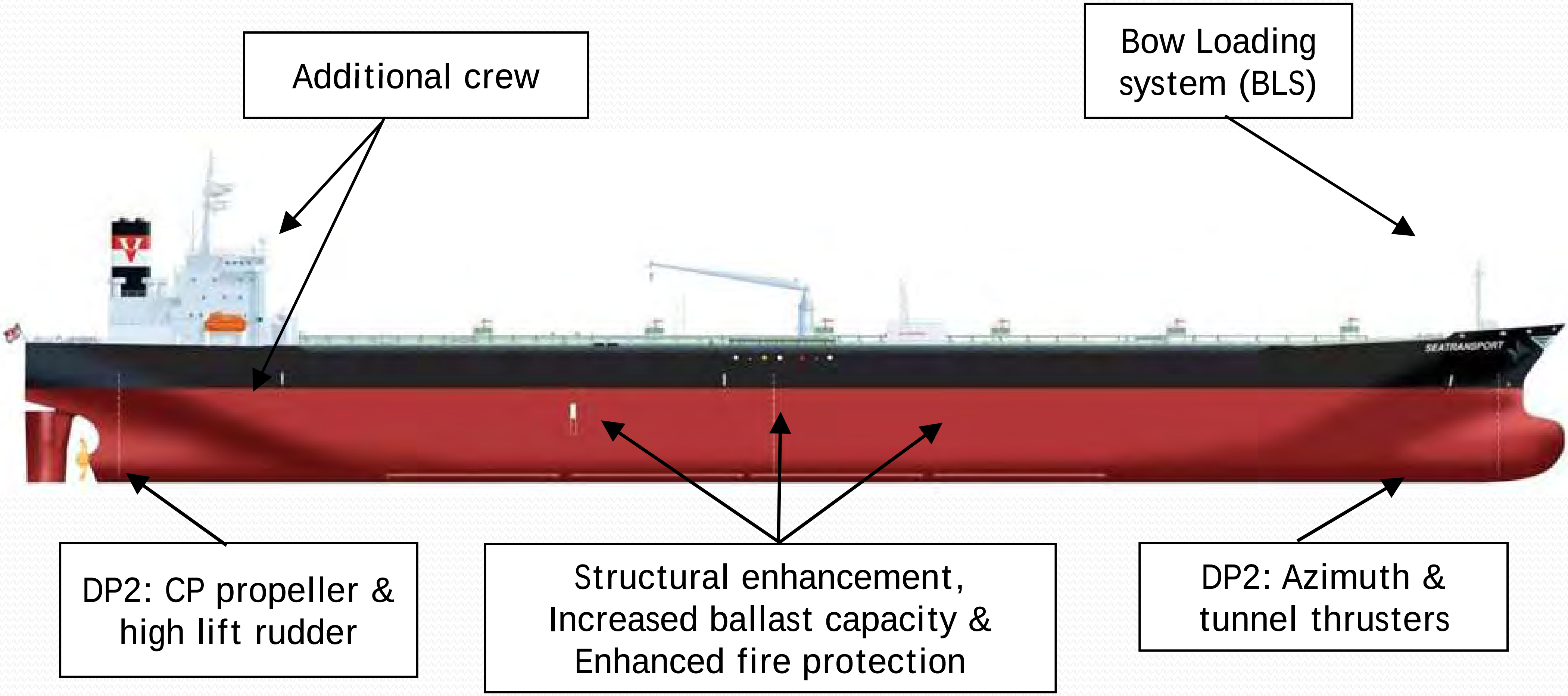






Source: Kongsberg

Shuttle Tanker Similar to a Conventional Tanker with a Few Exceptions



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

Source: DNV

The World's Fleet of DP Shuttle Tankers

	Year	Name	Deadweight		Class	Flag		Year	Name	Deadweight		Class	Flag
1	1996	SIRI KNUTSEN	35309	DP1	NV	United Kingdom	37	1995	ELISABETH KNUTSEN	124788	DP2	NV	Norway
2	1987	BETTY KNUTSEN	35807	DP1	NV	Norway (Nis)	38	1999	NAVION BRITANNIA	124821	DP2	NV	Norway
3	2000	SEVEROMORSK	39750	-	RS	Russia	39	1998	TRADER	125690	-	NV	Russia
4	1992	SEA SPIRIT	39977	DP1	NV	Liberia	40	2003	VINLAND	125827	DP2	AB	Canada
5	2001	RUBICON INTREPID	67436	DP	NV	Singapore	41	1997	EVI KNUTSEN	126352	DP1	NV	Norway (Nis)
6	1999	LAURITA	68139	DP	NV	Norway (Nis)	42	1992	JUANITA	126491	DP1	NV	Norway
7	1992	NAVION CLIPPER	78228	DP1	NV	Bahamas	43	2004	KOMETIK	126646	DP1	AB	Canada
8	2005	RUBICON VANTAGE	80745	DP1	NV	Singapore	44	1999	NAVION SCANDIA	126741	DP2	NV	Norway
9	2000	ABERDEEN	87055	DP1	AB	Bahamas	45	2004	NAVION ANGLIA	126749	DP2	NV	Norway
10	1992	NANCY KNUTSEN	91263	DP1	LR	Isle Of Man	46	1992	NAVION OCEANIA	126749	DP2	NV	Norway
11	1997	PETROATLANTIC	92995	DP2	NV	Bahamas	47	2001	NAVION HISPANIA	126779	DP2	NV	Norway
12	1989	PETRONORDIC	92995	DP2	NV	Bahamas	48	1987	STENA ALEXITA	127466	DP2	NV	Norway
13	1990	NAVION FENNIA	95195	DP1	LR	Bahamas	49	1982	STENA SIRITA	127466	DP2	NV	Norway
14	1996	BASKER SPIRIT	97068	DP	NV	Bahamas	50	2005	LEWEK FPSO 1	127533	DP	NV	Panama
15	2003	BERTORA	100257	DP2	NV	Bahamas	51	2003	KNOCK DEE	128358	-	NV	Singapore
16	2000	YURI SENKEVICH	100869	-	NV	Liberia	52	2002	RAGNHILD KNUTSEN	128772	DP	NV	United Kingdom
17	2005	VIKTOR TITOV	100899	-	NV	Cyprus	53	1987	ANNA KNUTSEN	129454	DP1	NV	Norway
18	2005	CAPTAIN KOSTICHEV	100927	-	NV	Cyprus	54	1995	LOCH RANNOCH	130031	DP2	LR	United Kingdom
19	1988	PAVEL CHERNYSH	100971	-	NV	Cyprus	55	1986	NAVION EUROPA	130596	DP1	NV	Norway
20	1999	VICTOR KONETSKY	101018	-	NV	Liberia	56	1981	NAVION NORVEGIA	130596	DP1	NV	Norway
21	1974	NORDIC MARITA	103894	DP1	NV	Bahamas	57	1999	OCEAN HOPE	134089	DP	NV	Singapore
22	1997	NAVION BERGEN	105200	DP1	NV	Bahamas	58	1988	CATHERINE KNUTSEN	141200	DP1	AB	Norway (Nis)
23	1981	NAVION SVENITA	106506	DP1	NV	Bahamas	59	1982	GERD KNUTSEN	146273	DP1	NV	Isle Of Man
24	1980	NAVION TORINITA	106852	DP2	NV	Bahamas	60	2004	GRENA	148553	DP2	NV	Bahamas
25	1998	NAVION AKARITA	107223	DP1	NV	Bahamas	61	1998	HEATHER KNUTSEN	148644	DP2	NV	Canada
26	1997	STENA NATALITA	108073	DP2	NV	Bahamas	62	2001	JASMINE KNUTSEN	148706	DP2	NV	Norway (Nis)
27	1993	NORDIC SAVONITA	108153	DP1	NV	Norway (Nis)	63	1999	NAVION STAVANGER	148729	DP2	NV	Bahamas
28	1991	TOVE KNUTSEN	111833	DP2	NV	Norway (Nis)	64	2001	NORDIC BRASILIA	150939	DP1	NV	Bahamas
29	1999	FRONT PUFFIN	112046	DP1	NV	Malta	65	1993	NORDIC SPIRIT	151294	DP1	NV	Bahamas
30	1998	VIGDIS KNUTSEN	123423	DP1	NV	Norway	66	1989	STENA SPIRIT	151294	DP1	NV	Bahamas
31	2000	BORGA	123665	DP1	NV	Norway (Nis)	67	1978	NAVION GOTHENBURG	152119	-	NV	Bahamas
32	1993	TORDIS KNUTSEN	123848	DP1	NV	Norway	68	2005	NORDIC RIO	152244	DP1	NV	Bahamas
33	1995	HANNE KNUTSEN	123851	DP2	NV	United Kingdom	69	1993	ATAULFO ALVES	152980	DP1	AB	Liberia
34	1992	MATTEA	124365	-	AB	Canada	70	2005	CARTOLA	153074	DP1	AB	Liberia
35	2006	RITA KNUTSEN	124472	DP1	NV	Norway (Nis)	71	2000	KAREN KNUTSEN	153616	DP2	NV	Isle Of Man
36	1999	RANDGRID	124502	DP1	AB	Norway	72	2005	SALLIE KNUTSEN	153617	DP2	NV	Isle Of Man

Source: DNV

History of Good Industry Collaboration on DP Performance

DP 2000 Joint Industry Project (JIP)

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

Field	Location	Unit Name	Lease/Own	Field Operator	Floater Owner	Storage Capacity, mbbl	Install Date	Water Depth, meters	Processing Capability	Station Keeping
- - - - In service at end of 2008 - - - -										
One true DP FPSO										
Marlim Leste	Brazil	*Seillean*	Lease	Petrobras	Frontier	310	2006	1,100	23,500 b/d oil 12 MMcf/d gas	Dynamic positioning
Galoc	Philippines	*Rubicon Intrepid*	Lease	Galoc Production	Rubicon Offshore	450	2007 (start up 8/08)	290	25,000 b/d oil	DP assist
BMG	Australia	*Crystal Ocean*	Lease	Roc Oil	Sea Production	42	2005	150	40,000 b/d oil 50 MMcf/d gas	Dynamic positioning
Various GOM fields	Mexico	*Bourbon Opale* (well test/service)	Lease	Pemex	Bourbon	11	2004	n.a.	15,000 b/d oil 27 MMcf/d gas	Dynamic Positioning
Various GOM fields	Mexico	*Toisa Pisces* (well test/ service)	Lease	Pemex	SeaLion	24	2003	n.a.	20,000 b/d oil 36 MMcf/d gas	Dynamic Positioning
Available	TBD	*BW Carmen* (temp. use as APTV)	Lease	TBD	BW Offshore	50	TBD	TBD	25,000 b/d oil 50 MMcf/d gas	Dynamic positioning
- - - - *Future service* - - - -										
Phoenix	US GoM	*Helix Producer I*	Lease	Helix Oil & Gas	Helix Energy Solutions	0	2010	1,200	45,000 b/d of oil 72 MMcf/d gas	Dynamic positioning
TBD	Brazil	*Dynamic Producer*	Lease	Petrobras	Petroserv	300	2010	2,500	30,000 b/d oil	Dynamic positioning

DP FPSO Precedents

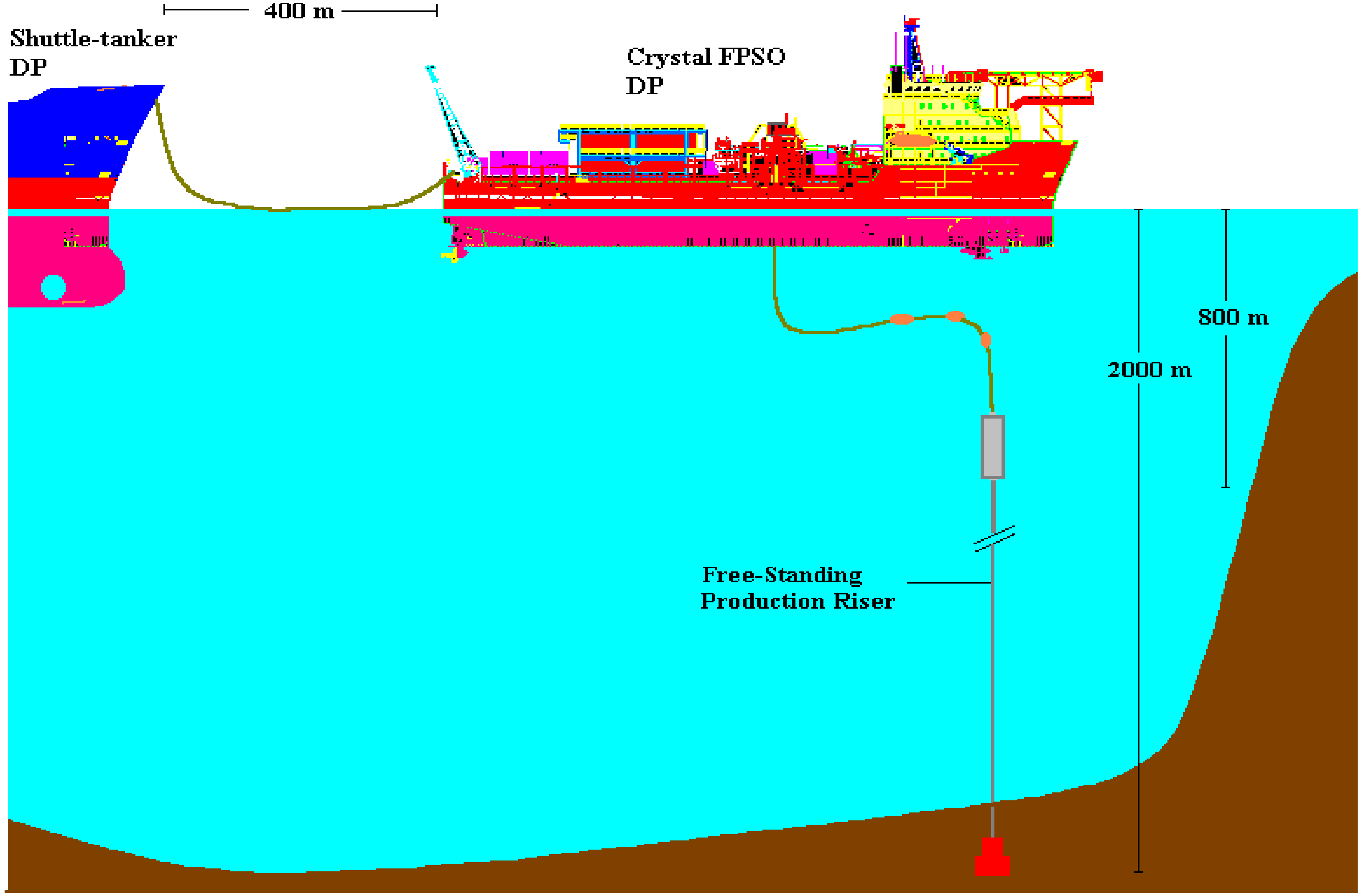
DP FPSO	Environment	Water depths	Years service	Storage capacity, bbl	
Seillean	Brazil	Deep	10		
	North Sea	Shallow	9	320,000	DP2
Crystal Ocean	Australia	Shallow	3		
	North Sea	Shallow	5	45,000	DP3
BW Carmen	Mexico GoM	Shallow	2		
(ex Crystal Sea)	North Sea	Shallow	6	50,000	DP2
Munin	S. China Sea	Shallow	1	600,000	DP?

The longest and most relevant experience is with *Seillean*, hence that is the basis of most of the analysis here.

DP FPSO: *Crystal Ocean* on DP Producing in UK Sector

A large offshore service vessel with DP3 and a process package on deck

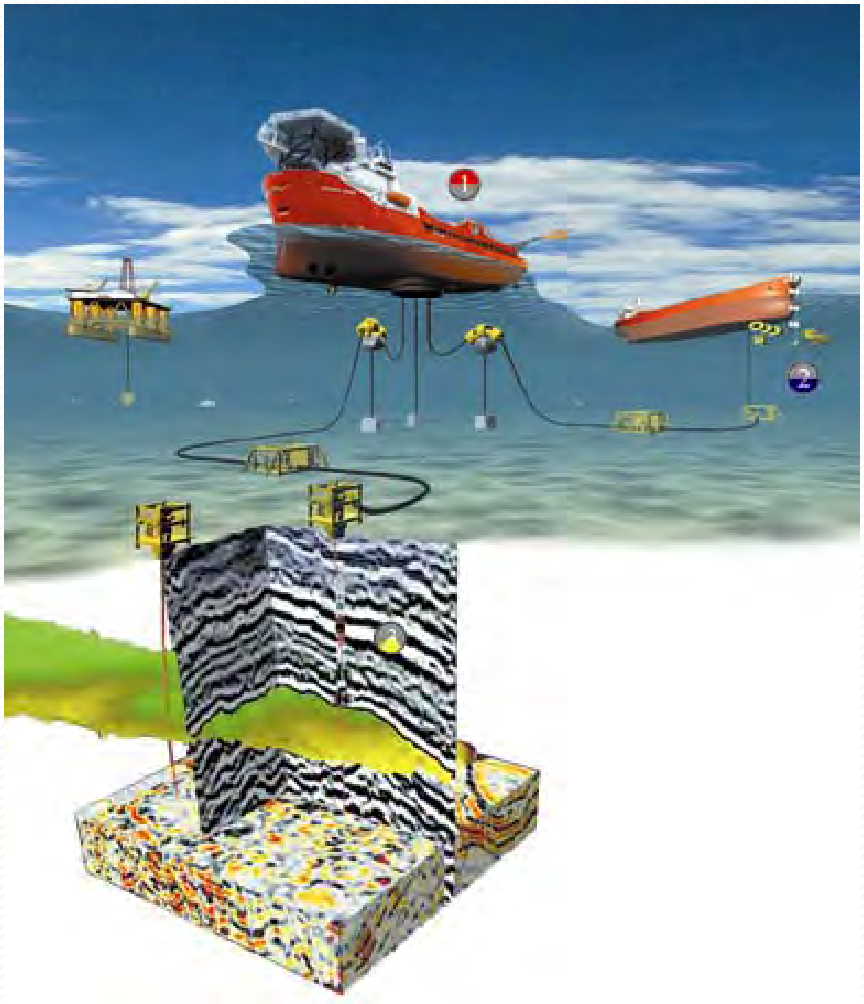
Operating Concept with Subsea Production: *Crystal Ocean* & *Crystal Sea* DP FPSOs



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

Crysta 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 *BP SWOPS*, operated at several fields – unusual cycle of loading then delivery to refinery

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

DP FPSO *Seillean* Today

Seillean **Summary Specification**

Hull: 250.0 x 37.0 x19.8m, 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

	Year	Production	Standby	Downtime
Transocean	1999	94.0%	1.4%	4.6%
	2000	98.1%	0.3%	1.6%
	2001	83.0%	15.6%	1.4%
	2002	58.1%	40.3%	1.7%
	2003	96.8%	2.9%	0.3%
Frontier	2004	67.3%	6.8%	25.9%*
	2005	93.7%	5.8%	0.5%
	2006	92.7%	7.2%	0.2%
	2007	99.7%	0.2%	0.1%
	2008	51.6%	0.1%	38.59%*

*Dry-docking in Rio

Disconnection Histroy - 1999-2009

	Year	Nº	Reason
Transocean	1999	2	Failure on the tensioning cable / Failure on the HPU
	2000	2	Problems with the DP System / Failure in the computer
	2001	2	Failure on the PMS / Failure on the KOS panel
	2002	2	Electrical problems during load power test
Frontier	2002	2	Severe weather conditions / Human error when controlling the EDP
	2003	1	Failure energy generation.
	2004	0	None
	2005	1	Electrical Problem on the PMS System.
	2006	0	None
	2007	1	Failure on the DGB governor
	2008	0	None
	2009	1	DP failure due to software error of new system.

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

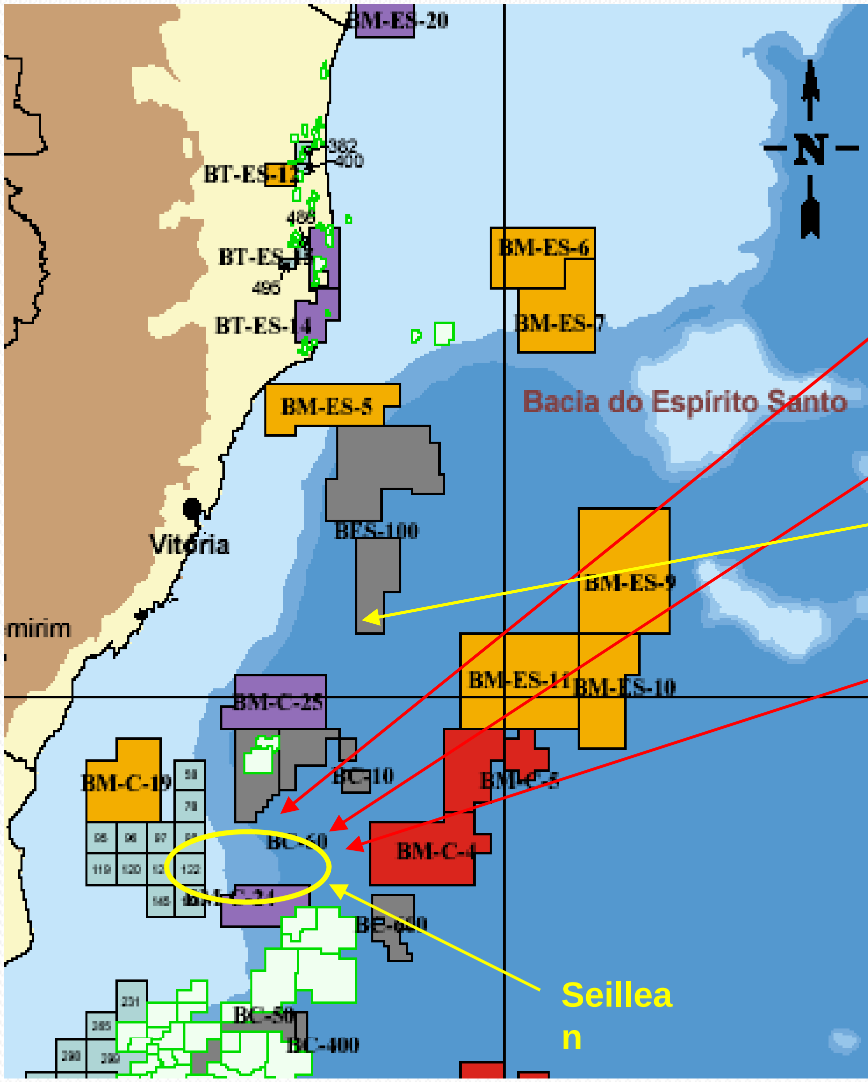
a. From the beginning of its offshore production in the mid 70s, Petrobras has used Early Production Systems (EPS) as a way to increase oil production, accelerate project cash flow and acquire better reservoir and environmental data for the specification / construction of "definitive" production units;

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.

Partial Petrobras History with *Seillean*



•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

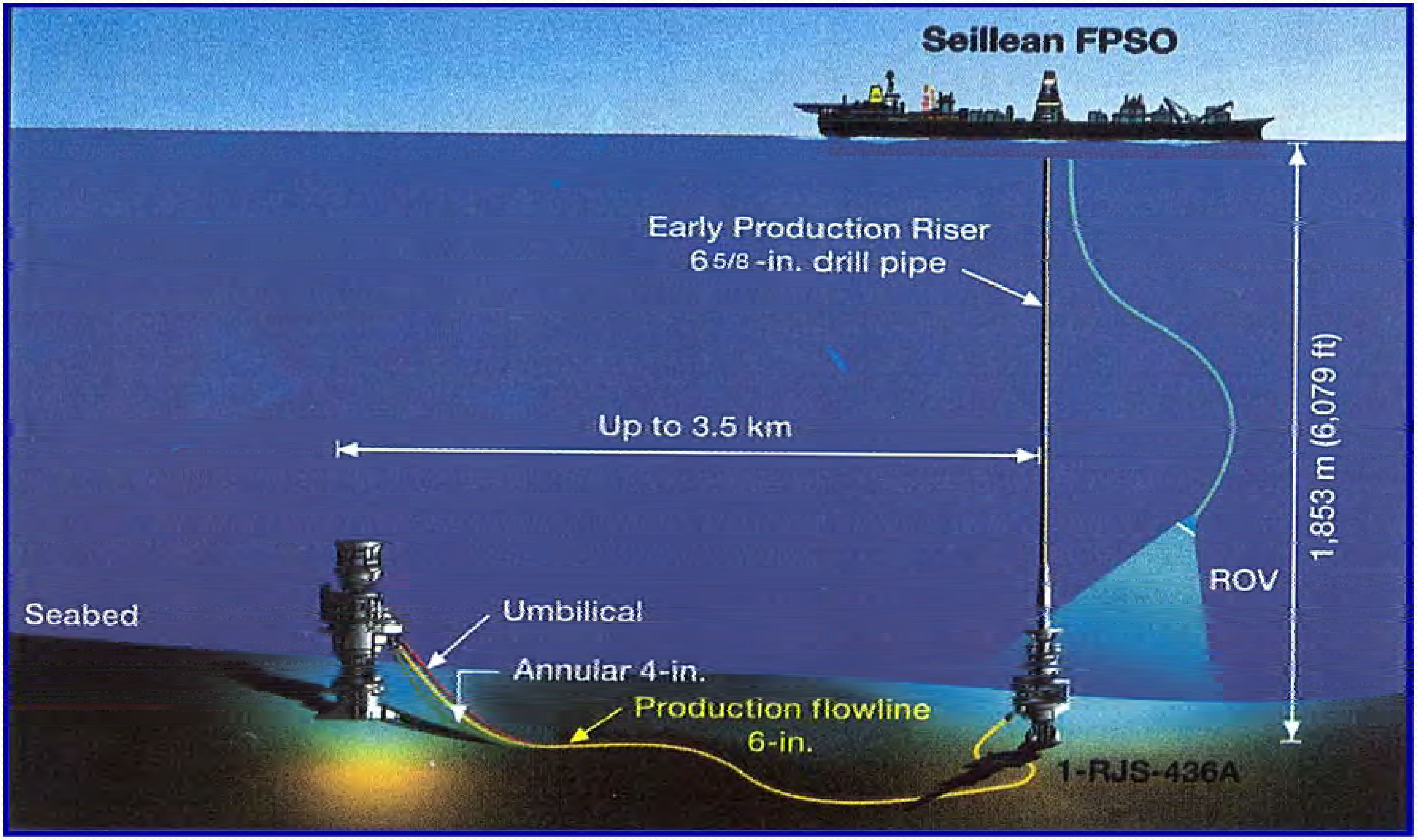
•October 2, 2003 Petrobras makes new discovery of light oil in block BC 60 - water depth 1824 meters

Petrobras’ internal task force study group has “scheduled” the Seillean as follows:

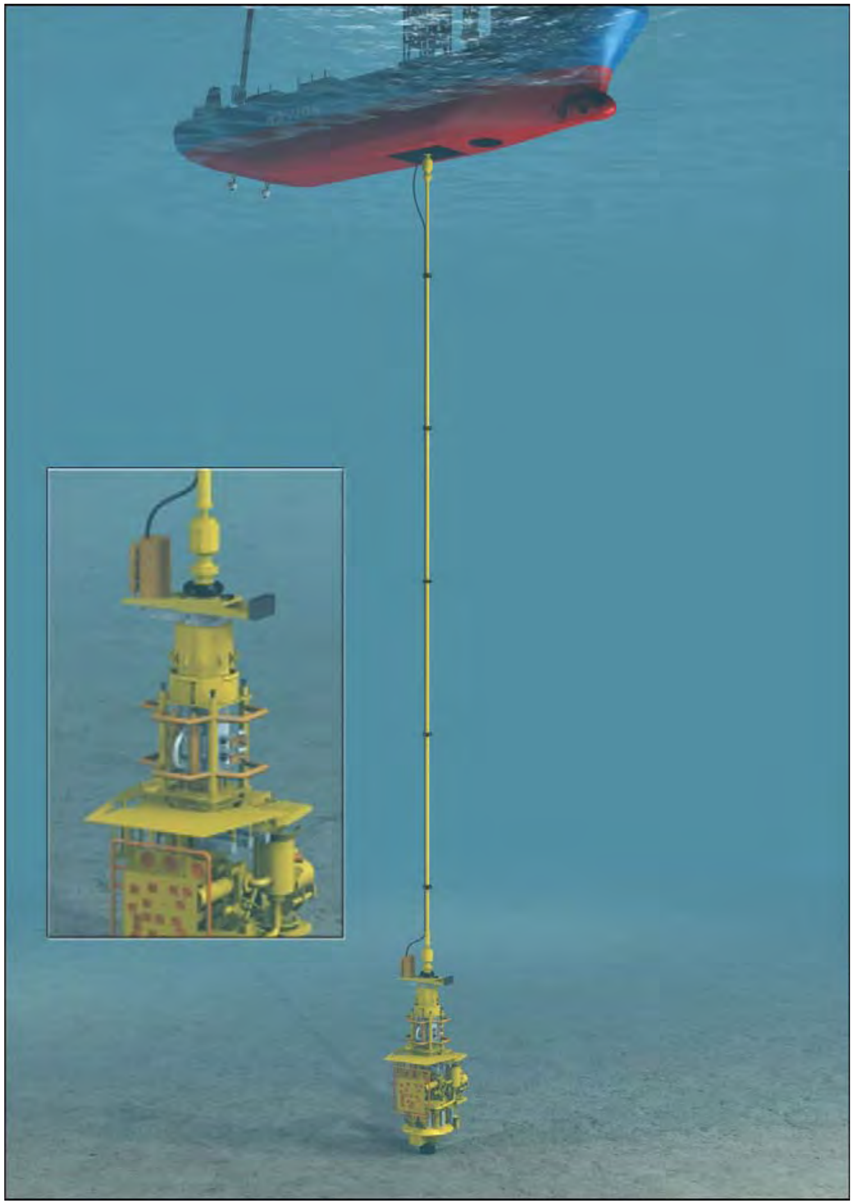
•Jubarte thru July 2005
•Cachalote July 2005 – October2005
•Well “A” October 2005 – January 2006
•Well “B” January 2006 – July 2006
•Well “C” July 2006 – Jan 2007
•Well “D” Jan 2006 – Jan 2008

Arrangement of *Seillean* at Roncador

Production from subsea well, simple to install



Riser System for *Seillean* - Single Drillpipe Riser



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;

<u>Result: operational life extended – expect further 15 to 20 years</u>

Offloading Operations

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

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.

The Future in US GoM:
DP Floating Production Unit (FPU) in 2010

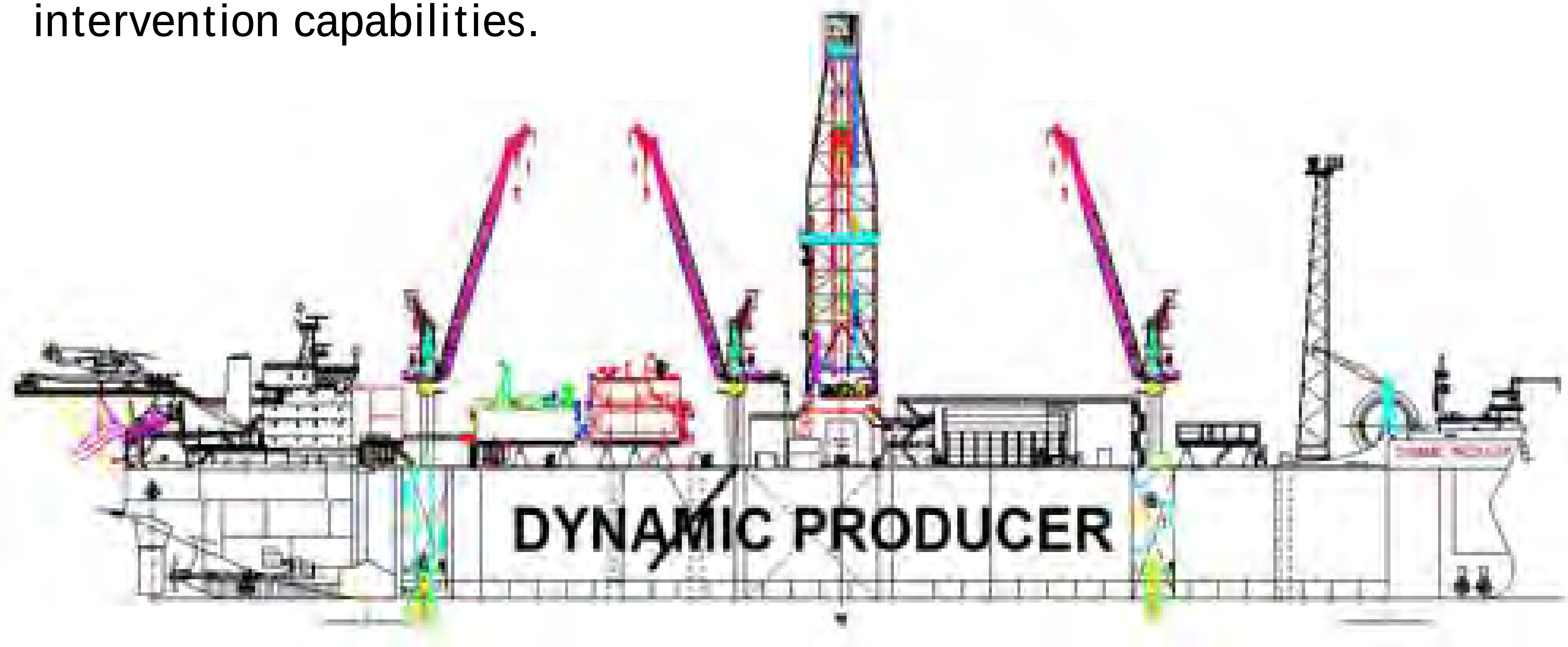
No storage

Note multiple risers with rapid disconnection system

The Future in Brazil:
Dynamic Producer "PIPA 2" to Enter Service in 2010

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.

4. The Path Forward for DP FPSOs . . .

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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