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US GoM FPSOs + Shuttle Tankers: Evolution, Drivers, Outlook

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Houston

Themes Today

Why so few FPSOs in US GoM despite leadership with other field development solutions?

Influences of Wesley Jones, Adam Smith and Kenny Rogers are all alive in deep water.

Living with it for 20 years - will it ever change?

FPSOs Considered for US Waters for a Long Time

The history behind where we are today

Year	Field Development	Location	Operator	Contractor	Comments
1977	Castellon (First anywhere)	<i>Spain</i>	<i>Shell</i>	<i>SBM</i>	<i>World's First true FPSO</i>
1981	Hondo	California	Exxon	Various	First FPSO in US waters
1996	Fuji	GoM	Texaco	None	Study that prompted DeepStar led industry wide support of EIS
1999	Na Kika	GoM	Shell	None	Exhaustive study of deepwater development options included FPSO
2001 December	Regulatory approval of FPSOs: US Department of Interior signs Record of Decision, approving FPSOs in GoM on basis of EIS				
2005	Mayhem: hurricanes Katrina and Rita damaged platforms, pipelines, MODUs adrift, caused rethink of design codes				
2007 August	<i>Cascade /Chinook</i>	GoM	Petrobras America	BW Offshore	Charters signed for FPSO + 2 shuttle tankers
2010 April	<i>BW Pioneer</i> arrives in GoM, 2 weeks before <i>Macondo</i> , delays, FPSO & shuttle tanker assist in spill				
Feb-12	<i>Cascade /Chinook</i>	GoM	Petrobras America	BW Offshore	Satisfy latest regulatory requirements, installation difficulties overcome

1981: Exxon Pioneers First FPSO in US Waters

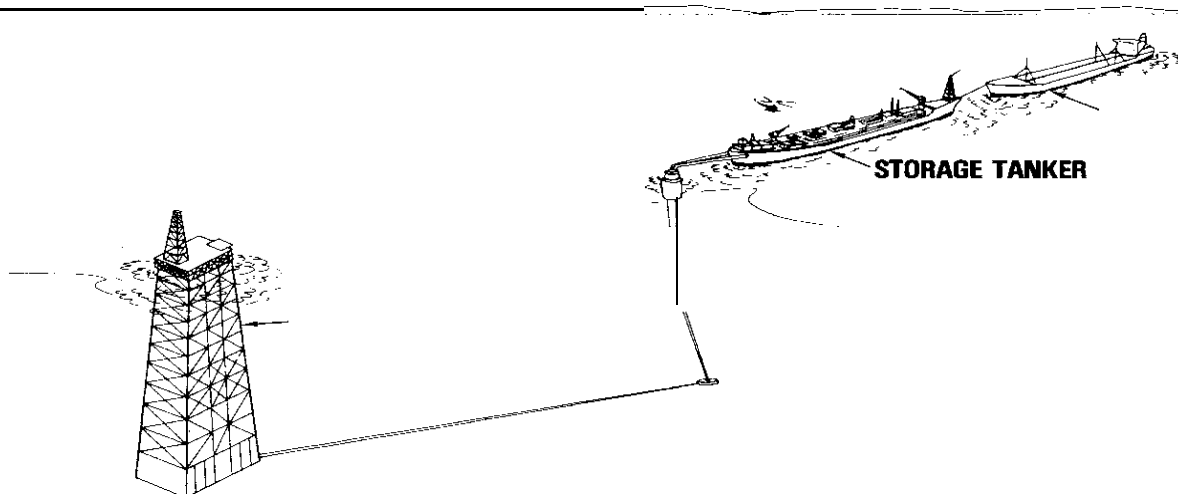
"OS&T" tanker offshore California



Exxon's OS&T moored at Hondo development offshore Santa Barbara;

50,000 dwt tanker for production plus shuttle tanker servicing;

OS&T (aka FPSO) is SALM Moored in 490 ft. of water, 1-1/2 miles from the *Hondo* platform in 850 ft. of water, roughly similar to Shell's *Castellon* installation 4 years earlier;



Pioneers on this project included:

N.A. Deacon, J.E. Hofferber,

T.E. Law, D.E. Masnada,

D.R. Olsen, R.E. Olson,

J.D. Rullmann, F.G. Vasser,

W.R. Wolfram

(All from Exxon)

Industry Campaign to Allow FPSOs in US GoM

1996-2001: doing something about it - roots in DeepStar



Allen Verret is a 45-year industry veteran from Texaco's Offshore Gulf of Mexico Operations, and until 2014 was the Executive Director of the Offshore Operators Committee and Technical Advisor to the Deepstar Regulatory Sub Committee.

Texaco had a prospect named *Fuji* in the then ultra deep of around 3,500 ft, remote from pipelines, looked like a field development candidate made for an FPSO;

Regulators required an Environmental Impact Statement (EIS) before allowing such a revolutionary system into GoM! Would take 2+ years and \$millions of effort;

Absence of an EIS would delay *Fuji* and other developments and make it difficult for any other operator to use the FPSO "tool in the toolbox";

About this time DeepStar was tackling the joint development of technologies by competing operators, such as concepts for deep water in GoM and elsewhere;

Hence DeepStar took on the task of securing regulatory acceptance of FPSOs in GoM and preparing the EIS. The "cat herding" leader for this complex multi year initiative was Allen Verret, who deserves great credit for this accomplishment.

Shell Pioneers (again)

1998-1999: Early and thorough consideration of FPSO in US GoM



George Rodenbusch led a number of early studies at Shell on FPSOs for GoM in 1998-1999, involving a large multidiscipline team from Shell and partner BP in assessing the feasibility of FPSO and other field development solutions for the *Na Kika* deepwater development in US GoM.



The semisubmersible at *Na Kika* that we know today was decided on after consideration of all kinds of options, including multiple variations on the FPSO theme;

Back then some people speculated on an operator prejudice in GoM against FPSOs;

No evidence of this was in the deliberations for *Na Kika* - quite the opposite, it was a skillful rational decision, based on all reservoir, production and facilities choices and open internal debate;

More on this and other FPSO history in two part series "*The First FPSO in the US Gulf of Mexico – The 14 Year Journey*" in SPE's Journal of Petroleum Technology, April & May 2010.

Environmental Impact Statement on FPSOs

2001: Key US regulatory policy documents on FPSOs

OCS EIS/EA
MMS 2000-090

Proposed Use of Floating Production, Storage, and Offloading Systems On the Gulf of Mexico Outer Continental Shelf

Western and Central Planning Areas

Final Environmental Impact Statement

Author

Minerals Management Service
Gulf of Mexico OCS Region

Prepared under MMS Contract
1435-01-99-CT-30962

Cover

*Turret-moored FPSO in a tandem offloading
configuration with shuttle tanker
(Illustration courtesy of Advanced
Production and Loading AS, 1999).*

Published by

MMS U.S. Department of the Interior
Minerals Management Service
Gulf of Mexico OCS Region

New Orleans
January 2001

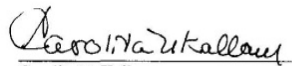
_____ **Alternative B-4** (Approve the general concept of using FPSO's with a requirement for an attendant vessel.)

_____ **Alternative C** (No action at this time (insufficient information to make a decision)).

_____ **Other** _____

This decision, authorized by the signature below, and this Recommendation and Decision Document together establish the Agency's Record of Decision on the Environmental Impact Statement prepared on the Proposed Use of Floating Production, Storage, and Offloading Systems on the Gulf of Mexico Outer Continental Shelf, Western and Central Planning Areas. This programmatic decision is effective immediately. This decision does not constitute approval of any specific FPSO project. Submission, review, and approval of all required OCS plans, permit applications, and other submittals must be completed for every proposed FPSO system.

Dated: 13 December 2001


Carolita U. Kallaur
Associate Director for
Offshore Minerals Management

The signed Record of Decision:
US Government says FPSOs OK
in principle in GoM

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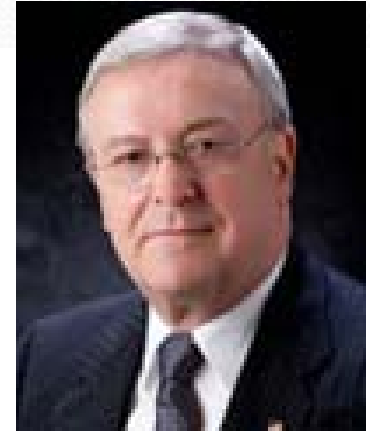
Devon the True Independent

2003-2009: An independent force in US GoM



W.D. (Dave) Bozeman was Vice President at Devon Energy Corporation in Houston, responsible for the Project Support Office, set up to plan and manage major projects, before Devon's sell down of deepwater assets.

- a. No ownership in pipelines or refineries: the export of oil and gas to shore driven by open consideration of all options: FPSOs plus shuttle tankers openly competed in field development studies with Spars and Semisubmersibles;
- b. Searching for nimble solutions to reach first oil early, e.g. try EPS if overall it gets us there faster with lower risks;
- c. Large acreage position in remote ultra deep waters of Lower Tertiary: second after Chevron, huge potential impact on company;
- d. 50:50 with Petrobras at *Cascade*;
- e. Then Devon chose to completely exit offshore in 2H 2009!



Peter Lovie, Senior Advisor Floating Systems. Seriously in the loop on contracting for FPSO and shuttle tankers at *Cascade / Chinook*, then later in deliberations on other GoM field developments for Devon

Serious Progress on FPSOs for US GoM

- 2006
- + Petrobras takes over operatorship of *Cascade/Chinook*;
 - + Major find: BP's *Kaskida* in Keathley Canyon, a future FPSO?
 - + Petrobras and partners announce plans for first FPSO in US GoM at *Cascade /Chinook*. **Choice driven by reservoir conditions**;
 - + Industry realizes have to change FPSO designs to adapt to more severe storm criteria for US GoM;
 - + Realization among operators of MODU-FPSO collision risk and hence spill risk: disconnection of FPSOs was essential in US GoM.
- 2007
- March Bids solicited for the third FPSO in GoM but first on US side - for a minimum lease of five (5) years + options 1 + 1 + 1 ;
- May OTC: GoM design practices extensively revised, tightened;
- August Stiff competition on contract for FPSO, signed with BW Offshore for Aframax size FPSO for a record 8,200 ft. w.d. First disconnectable turret for GoM. Used free standing buoyed riser system.
- First Jones Act shuttle tankers for US GoM assessed, fewer choices than for FPSOs, time charters signed: 2 Handymax size from OSG.

Pioneer-ing for US GoM

FPSO conversion in Singapore, shuttle tankers built in Philadelphia

The *BW Pioneer* in GoM waters



US construction of shuttle tankers



Conversion at KeppelFels



Source: Petrobras

Shuttle tankers owned by US company, crewed by US citizens



Good News and Bad News

2008 Hurricane *Ike* reminds industry – and the residents of Houston – that hurricanes are hazardous to health and property!

2009 Another big find announced: BP's *Tiber* in Keathley Canyon;

2010 April First FPSO for GoM: *BW Pioneer* arrives in GoM from Singapore;

April *Macondo* disrupts everything;

BW Pioneer assists;

2011 Shuttle tankers available, diverted to Brazil;

Installation difficulties for FPSO at *Cascade/Chinook* adds to delays from *Macondo*;



Petrobras America patiently soldiers on!

The First FPSO in US GoM: BW Offshore's *BW Pioneer*

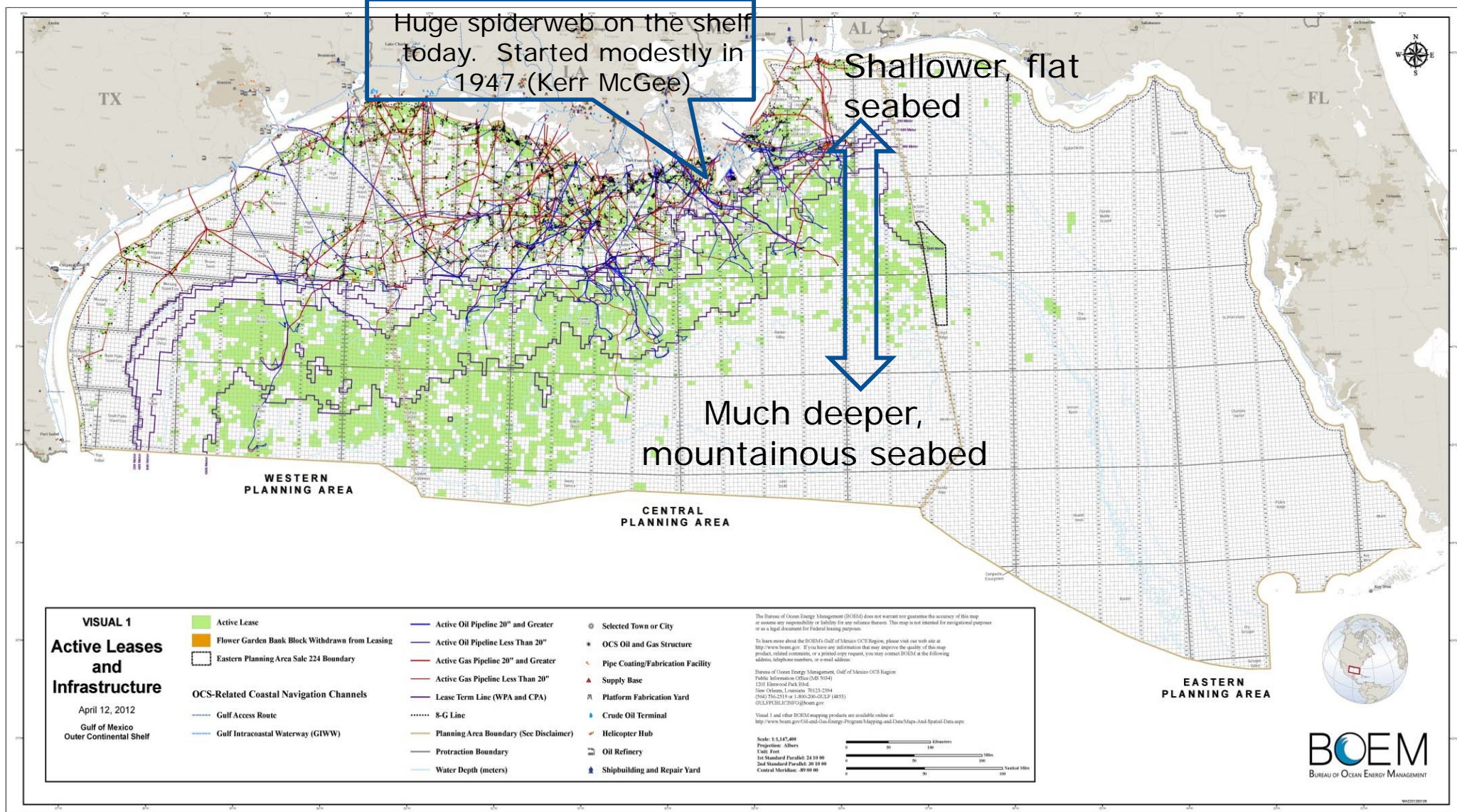
At last! First oil: 25 February 2012



Source: Petrobras

Growth in Platform & Pipeline Infrastructure

Unlike many offshore regions with FPSOs, ALL production **IMPORTED**



In recent years development & production risks and economics been tougher than expected for very remote areas in Ultra Deep Water (UDW): not just effects of location and UDW, formations also not as well understood

Contrasts Help Explain Lack of FPSOs

Shallow and out to what's now deep

Developed in 1940s to 1990s

Wells often 5,000-20,000 ft. RKB;

Pipelines economical, competitive infrastructure;

Little need or opportunity for FPSOs: **no need for storage for export;**

Well developed understanding of geology;

Remote UDW: high stakes, high risks

2000s & 2010s

Wells much more difficult: sub salt, often 25,000-35,000 ft. RKB;

Pipelines across mountainous sea bottom in 5-10,000 ft. water depth difficult, expensive;

Few analogues on reservoirs, high risks on reserves and producibility;

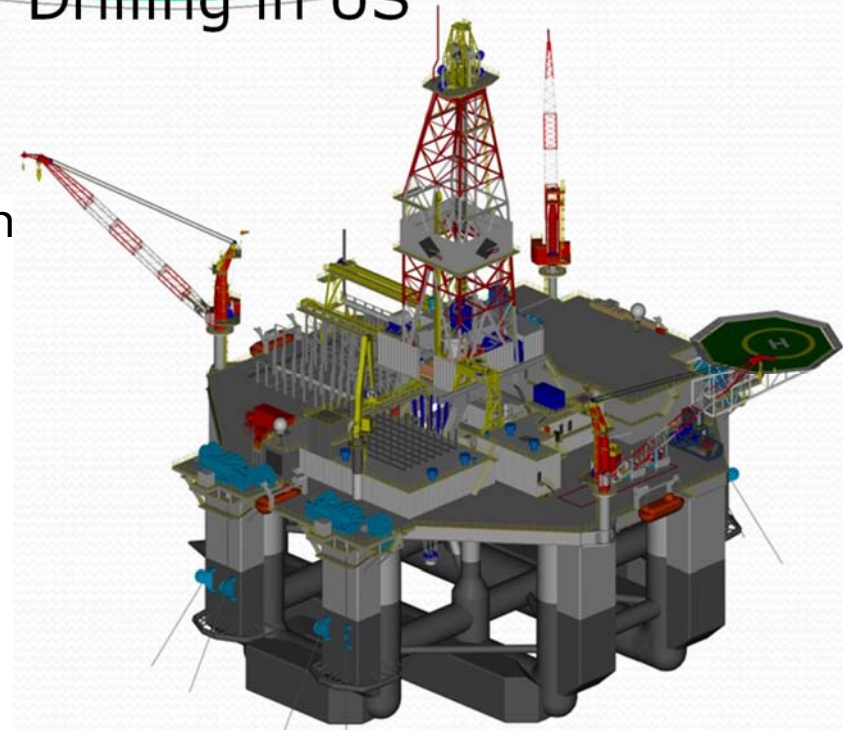
\$Megabillion projects common!

If it production goes badly, FPSO can be a least cost escape!

Fundamental Shift in Emphasis: Risks, Economics with UDW Drilling in US

Drilling and completion for one well may easily take six (6) months in the Lower Tertiary in GoM and an investment in the region of \$250+ million per producing well;

Well costs dramatically high for the Lower Tertiary: some of it day rates, lot to do with subsalt well characteristics;



Facility choices more driven by drilling than ten years ago: **well CAPEX about 2/3 now of field development, instead of 1/3 before.** Major choice is to drill from platform, OR from MODU(s) with subsea completions;

Developments may take several years to drill up, hence production ramp up may be slower;

Post spill, drilling costs even higher.

Wesley Jones - The Pipeliners' Friend in Washington

No Jones Act for
Trucking:
Izuzu, Volvo OK,
**U.S. FREE
MARKET !**



No Jones Act for
Airlines:
Airbus, Bombardier,
Embraer all OK.
**U.S. FREE
MARKET !**

The Jones Act applies to ships engaged in coastwise trade in US waters: requires US built vessels, 75+% US owned, US crew. CAPEX about 3X international trade for tankers transporting oil, OPEX ~ 2X.

A production platform is considered a US port, so delivery of production from a production facility to shore is "coastwise trade".

Senator Wesley Livsey Jones (1863-1932), Republican from the state of Washington, author of the **Jones Act passed in 1920**, intended to protect his state's trade with Alaska, a measure acceptable in the protectionist times of the 1920s.

Strong union and industry lobbies (seafarers, shipyards, railroads), have resisted efforts to repeal. Costs USA about \$10billion/year (Senator John McCain, R-AZ, 2002). Difficult politically and practically to make a change!

2001-2005 Shuttle Tanker Competitors

US GoM Business

By law use of Jones Act and OPA 90 compliant tankers was mandatory (double hulled). Access to US GoM ports limited draft to a maximum of 40 ft.

- + Both shuttle tanker companies committed to meet these requirements;
- + Both were headquartered in Houston;
- + Both challenged the pipeline network, making it possible to play a spot market for crude production;
- + Both chose to use DP2 vessels, emulating proven safety practices from North Sea.

Thereafter the approaches differed:

Seahorse Shuttling

Active 2001-2004

Company US controlled, Newbuilds.
New design, GoM construction
Tanker operating company owned
by US operating oil company:
Conoco Inc.

American Shuttle Tankers

Active 2002-2005

Company foreign controlled, use Conversions.
Lease tankers from Jones Act US Owner.
Operating company owned by 50:50 by Navion
(now Teekay), the leading North Sea shuttle
tanker provider and Skaugen PetroTrans, a
leading GoM lightering company

Market Dream: Freedom to Take your Production Where you Want, When you Want

Unlike pipelines, flexibility of shuttle tankers serve any combination of production locations (red dots) and sales destinations (blue dots)



Click anywhere in map to start/stop animation. Be sure to turn on sound!

In One Corner We Have . . .

Seahorse Shuttling & Technology, a unit of Conoco



Newbuilds:

Seahorse GoMAX 550 shuttle tanker design: 550,000 bbl capacity / 80,000 dwt.

A standard Aframax tanker would be too big to get into GoM ports: hence decision to use special design to maximize capacity for “design envelop”.

GoMAX 550 shuttle tankers were to be built via an alliance of Conoco, Samsun and Alabama Shipyard, formed to enable construction of this new design customized to US GoM conditions, while employing international best shipbuilding practices.

Substantial investment was made in front end design and planning.

And in the Other Corner We Have . . .



Conversions of existing tankers from Seabulk: Double Eagle Crude / Product Carriers:

Length OA	183 m
Length BP	74.3 m
Beam	32.2 m
Depth (side)	19.15 m
Depth (centerline)	19.75 m
Design draft	11.2 m
Scantling draft	12.2 m
Deadweight design	40,877 mt
Deadweight scantling	46,094 mt



Seabulk Mariner • Seabulk Arctic • Seabulk Pride

Side note on jobs: Although US built tankers were required under the Jones Act, if could use foreign built tankers with US crews, AST estimated that the total man years of US employment would be much greater.

One Approach to Choice of Vessel



Conversion of existing double hulled OPA 90 compliant Jones Act tankers to DP2:

Proposed shipyard work:

Bow Loading Systems (BLS)

2 additional generator sets

Tunnel thrusters, 1 forward and 1 aft

1 combined retractable tunnel & azimuth thruster

Controllable Pitch Propeller (CPP)

Helideck

DP2 system controls and communications

Piping systems for BLS and VOC returns

Paint repair



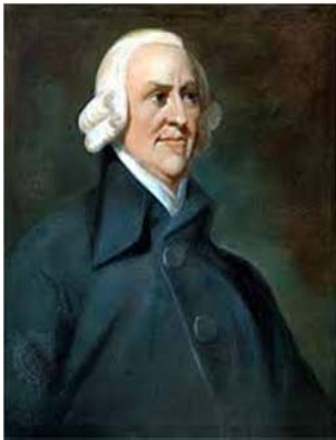
The *Cascade/Chinook* Shuttle Tanker Bid Process

From 2005 to 2007 there was really no shuttle tanker business being pursued by the providers - and little demand seen.

Then in 2007 Petrobras America opened up a requirement for the *Cascade/Chinook* development.

The market had not been there when the earlier shuttle tankers providers were active. Unfortunately the Jones Act supply side was thin, not like elsewhere in world. A few 30 year old hulls could be updated. Or use ATBs? Or adapt the few new hulls shortly available? Deliveries on critical path.

The principle of the free market was again at work in deep water!



Adam Smith's ideas of 231 years ago still apply!
He would have been would have enjoyed it!

Adam Smith, professor of philosophy at University of Glasgow and author of "*Wealth of Nations*" in 1776, describing the function of a free market . Born in Kirkcaldy. Fife

Shuttle Tanker Operating Criteria in US GoM

Adapting North Sea (per DNV) or Brazil (per PBR) Practices

Maximum sea conditions for <u>connection</u> :	<u>Hsig, meters</u>	
Enhanced maneuverability, non DP, Handymax tankers at <i>Cascade/Chinook</i> per Brazil practice (PBR):	2.5	
DP2 Handymax per DNV / North Sea practice (DNV)	2.5	
Maximum seas before <u>disconnection</u> :		
Handymax, non DP, per Brazil practice (PBR):	3.4	
DP2 Handymax per DNV / North Sea practice (DNV):	2.5	
	- Tugs required -	
	<u>Offshore</u>	<u>In port</u>
Enhanced maneuverability, non DP, Handymax tankers at <i>Cascade/Chinook</i> :	2	2
DP2 Handymax, DNV North / Sea practice:	- -	none - -

**Interesting comparisons on safety assumptions,
operating economics and easily available equipment!**

And the Winner Is . . .



- US GoM Shuttle Tanker from OSG: Handymax size, with BLS and enhanced maneuverability (thrusters and controllable pitch propeller) but not DP.
- First two chartered in 2007, entered service in 2010, a third chartered in 2013 for operation in 2016.
- Design that American Shuttle Tankers had in mind in 2002 was similar except that their tankers would have been DP2.

Shuttle Tankers Finally in Operation in US GoM



Offloading from an FPSO to a shuttle tanker in US GoM

Petrobras operated *Cascade/Chinook* development, with FPSO *BW Pioneer* on charter from BW Offshore

Two shuttle tankers chartered from OSG

Shuttle Tankers & FPSOs in US GoM v. Elsewhere

<u>Shuttle tankers</u>	<u>US GoM</u>	<u>N. Sea, Brazil, Elsewhere</u>
Operators free to export production to destination of choice?	<i>No</i>	Yes
Typical shuttle tanker capacity, bbl:	<i>330,000</i>	650,000 or 1,000,000
Market economics:	Jones Act only <i>2-3 x intl mkt</i>	International market

Shuttle tankers at a half or a third of the size used elsewhere in the world, employed 2 to 3 times international market rates, make shuttle tankers not exactly a cost competitive proposition for US GoM !

<u>FPSOs</u>	<u>US GoM</u>	<u>N. Sea, Brazil, Elsewhere</u>
FPSOs <u>existing</u> *	<i>1</i>	178
FPSOs <u>on order</u> *	<i><u>1</u></i> <i>2</i>	<u>36</u> 214

FPSOs in US GoM are unusual: must be disconnectable, only in very remote, very deep locations But they don't have to be Jones Act compliant !!!

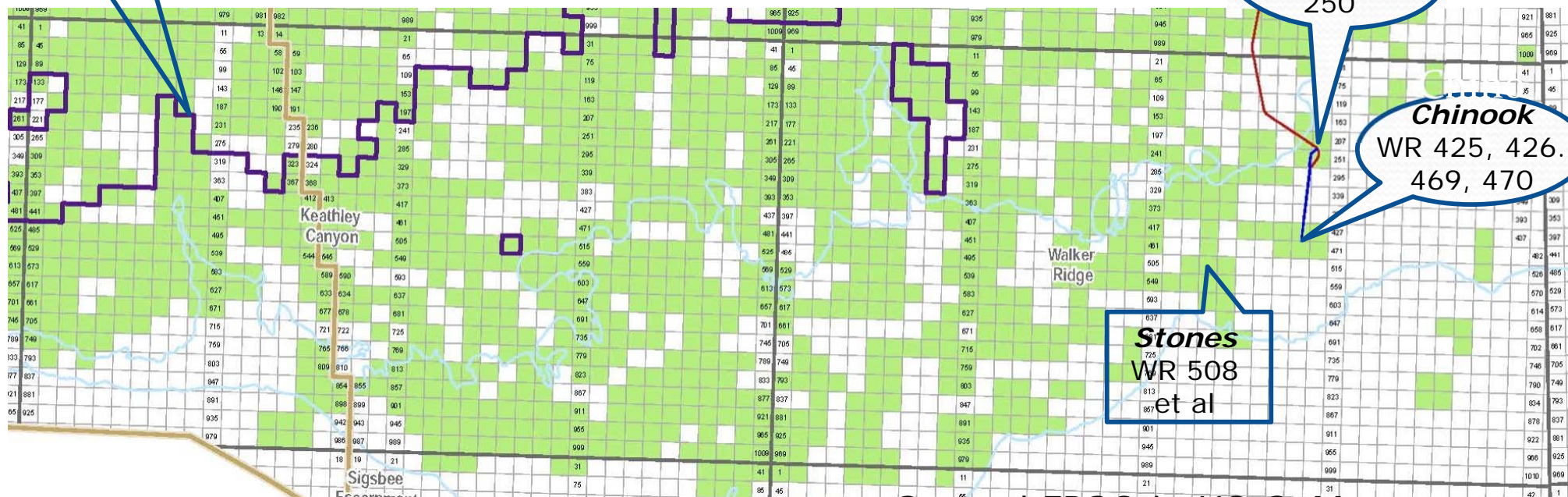
* McCaul, J.: "Floating :Production, What's New in October 2014" Maritime Reporter, pp. 52-53, October 2014

FPSOs in the UDW in US GoM

Possible third FPSO in US GoM: BP operated, at studies stage

Gila KC 93
Kaskida KC 130
 292
Tiber KC 102

Petrobras operated *Cascade* & *Chinook* producing to *BW Pioneer*, the first FPSO in US GoM



Cascade
 WR 206, 249
 250

Chinook
 WR 425, 426.
 469, 470

Stones
 WR 508
 et al

Second FPSO in US GoM: Shell operated *Turritella* FPSO for their *Stones* development, under construction

Map credit:
 BOEM, 12 April 2012, same as slide 3,
 available on U.S. BOEM website

Comparison of FPSOs in US GoM

Status:	Operating	Contracted	Studies
FPSO Name:	<i>BW Pioneer</i>	<i>Turritella</i>	???
Year enters service:	2012	2016	2020
Operator:	Petrobras	Shell	BP
Leased or Owned:	Leased	Leased	Owned ?
FPSO Owner:	BW Offshore	SBM Offshore	BP ?
Hull size:	Aframax	Suezmax	VLCC as Hub
Field Development:	<i>Cascade/ Chinook</i>	<i>Stones</i>	<i>Kaskida / Tiber / Gila</i>
Nameplate production rate, bopd:	80,000	60,000	100,000 ?
Water depth, meters:	2,500	2,900	1,500-1,700
Information sources:	- Industry publications -		Informed Guess

The pace of 2012-2020 is nothing like that of Africa, Brazil and elsewhere in the world !

It Has Had to be Worthwhile to Choose an FPSO

In years past FPSOs have been included as one of multiple field development solutions considered – TLPs, Spars, Semisubmersibles, FPSOs. At one point FSOs plus shuttle tankers were considered instead of a pipeline network.

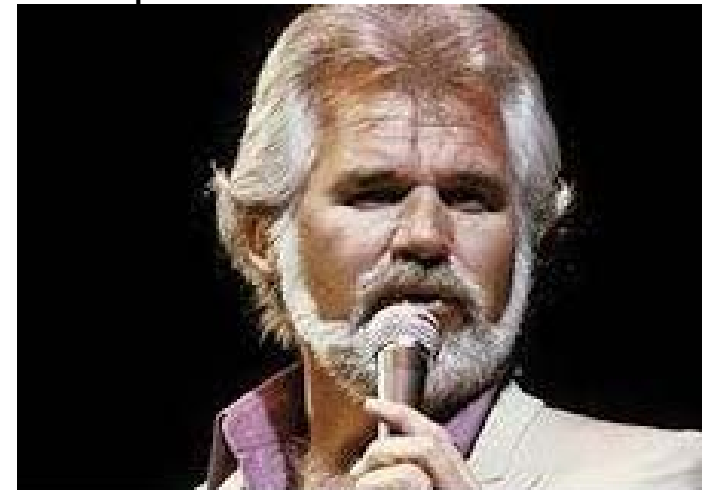
Been good reasons why this slow pace in US GoM - geology, location, reservoirs, risks, returns.

In arriving at an outlook for FPSO plus shuttle tanker business market talk of FPSOs has to be viewed cautiously.

Only now in a few cases for certain reservoirs in remote very deep locations has the FPSO become a worthwhile risk return choice for operators.

Kenny Rogers had it right in the chorus of *The Gambler*:

*"You got to know when to hold 'em,
Know when to fold 'em,
Know when to walk away,
Know when to run"*



Sums up risk management !

Closing Thoughts

US GoM FPSOs + Shuttle Tankers

1. FPSOs been seriously considered for field developments in US GoM for at least the last 18 years;
2. “We often don’t tell you why we made the decisions we did” - a common comment from operators!
3. No mystery on what has been going on with FPSOs for US GoM: field development realities, operator philosophies – rational reasons for where we are;
4. Low acceptance of FPSOs in contrast to other parts of the world can be attributed to geography, import of production, infrastructure, other development options and reservoir conditions;
5. Only since 2012 has one FPSO been producing oil and gas in US GoM with a second slated to enter service in 2016;
6. Likewise shuttle tankers have been seriously considered for many years for delivery of crude oil from offshore locations to the many US refineries around the coast of US GoM;
7. Outlook for more FPSOs and shuttle tankers in US GoM: one more FPSO by end of decade + maybe two more shuttle tankers.
8. Wesley Jones, Adam Smith and Kenny Rogers all continue to exert their influence in the deep waters of US GoM.

. . **Thank you** . .

Questions?

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