FPSOs and the US Gulf of Mexico:
The Differences,
the 14 year Journey to the First FPSO in GoM
and the Future

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Today’s Themes - Understanding FPSOs for GoM

1 Reservoirs, infrastructure and history;

2 Regulatory environment and climate;

3 Pipelines, shuttle tankers and the Jones Act;

4 The new world of The Lower Tertiary;

5 What may be ahead for FPSOs in GoM.
Words of Wisdom!

There is nothing more difficult to take in hand,
More perilous to conduct,
Or more uncertain in its success,
Than to take the lead in the introduction of a new order of things.

Machiavelli, “The Prince”, Chapter 6, 1513
The world fleet in service at the end of 2008 comprised:

<table>
<thead>
<tr>
<th>Type</th>
<th>Count</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Floating Production Storage Offloading (FPSOs)</td>
<td>144</td>
<td>Mostly tanker conversions, some newbuilds</td>
</tr>
<tr>
<td>Floating Storage Offloading (FSO) vessels</td>
<td>86</td>
<td></td>
</tr>
<tr>
<td>Semisubmersibles</td>
<td>42</td>
<td>Generally field specific newbuilds</td>
</tr>
<tr>
<td>Tension Leg Platforms (TLPs)</td>
<td>22</td>
<td></td>
</tr>
<tr>
<td>Spars</td>
<td>16</td>
<td></td>
</tr>
<tr>
<td>Production Barges</td>
<td>6</td>
<td>Various</td>
</tr>
<tr>
<td>Floating Storage Re-liquefaction Units (FSRU)</td>
<td>2</td>
<td>Conversions</td>
</tr>
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Source: International Maritime Associates
No FPSOs (Yet) in GoM, Where “Offshore” Started

1. First offshore production happened in GoM, first time out of sight of land in 1947 (Kerr McGee), extending platform and pipeline technologies from the inshore marshes;

2. Fixed platforms and then floating platforms gradually evolved as water depths grew and became more remote and in deepwater water. Wells often drilled from platforms & required intervention;

3. First FPSO in the US Gulf of Mexico in mid 2010 - applying technology used elsewhere in the world but a latecomer to a mature offshore region with established export infrastructure and regulatory hurdles;

4. Shuttle tankers in the US Gulf of Mexico - restrictive laws (Jones Act) for crude oil transport from production vessel to port: tankers must be by US flag, US owned tankers. High costs make it difficult;

5. After a laborious 14 year journey the use of FPSOs and shuttle tankers will be achieved in the US Gulf of Mexico (GoM) next year.
Remote Deep Wells Stretch Drillers, And Slow Field Developments

Extreme depths: 30,000+ ft. RKB not unusual, e.g. BP’s *Tiber* discovery in Keathley Canyon, announced September 2009 is a 35,000+ ft. well depth!

Extreme pressures in reservoirs, e.g. 18-22,000 psi;

Mountainous seabed;

Reservoir rocks with little production history;

MODU availability limited, long deliveries;

Experienced people in operator, drilling contractor and vendor organizations are more critical than ever for wells like these;

But these people are in short supply.
Drilling and completion for one well may take six (6) to nine (9) months in the Lower Tertiary and an investment in the region of $250+ million per producing well;

Well costs dramatically high for the Lower Tertiary: partly day rates, partly well characteristics;

Facility choices more driven by drilling than 5-10 years ago: well CAPEX about 2/3 now of field development, instead of 1/3 before;

Developments may take several years to drill up, hence production ramp up may be slower.
## History and Hurdles for Facility and Transportation Systems in GoM

<table>
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<th>Technology</th>
<th>Hi/Low Tech?</th>
<th>Significance</th>
<th>Barriers</th>
<th>Timing: Serious Study to First Commercial Use</th>
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<td>1 Traditional Facility: GoM Production Platforms</td>
<td>Originally Low, now High</td>
<td>A new way of doing things, a game changer</td>
<td>Risking production on success of a new technology, water depths</td>
<td>1947-2009: evolution over 63 years</td>
</tr>
<tr>
<td>2 Traditional Transportation: GoM Pipeline Networks</td>
<td>Originally Low, now High</td>
<td>Traditionally laid over flat alluvial sea bottom, economical and efficient</td>
<td>2005 hurricane season revealed serious vulnerabilities, water depths</td>
<td>1947-2009: evolution over 63 years</td>
</tr>
<tr>
<td>3 The New Facility in GoM: FPSOs</td>
<td>Medium</td>
<td>Been used everywhere else in world</td>
<td>Competition of other production systems / regulatory acceptance</td>
<td>1996-2010: almost 14 years</td>
</tr>
<tr>
<td>4 New Transportation Method for GoM: Shuttle Tankers</td>
<td>Low</td>
<td>Modest version of North Sea precedent</td>
<td>Competition of pipeline network / Jones Act (US protectionism)</td>
<td>2000-2010: roughly 10 years</td>
</tr>
</tbody>
</table>
A Sound Business Case Can Exist for FPSO and Shuttle Tankers in GoM

i. Export matters: Shuttle tanker export may indeed offer an economic benefit over pipelines, even for large fields in the remote ultra deepwater of GoM (e.g. Lower Tertiary): could be in the order of a $Billion saving over field life;

ii. Downside risks: In the event of a field being a bust, FPSO and tankers being re-deployable mitigate risks on export service commitments. Pipelines are not good at being reeled up and redeployed!

iii. Aggregation: Large enough volumes enable an economic pipeline system - more difficult in the Lower Tertiary than closer to shore. A pipeline is economically difficult for EPS - risks and economics favor tankers;

iv. Flexibility: Tankers can easily change destinations for maximum margin from production - and in event of hurricane damage can be re-directed to alternate delivery points.

v. Producibility: Can one reliably depend in remote field developments producing from unproven formations?
Although FPSOs used widely elsewhere in the world, starting in the 1970s, they are new to the US GoM, even though GoM saw the first production offshore (1947, Kerr McGee) and has been a consistent pioneer in offshore operations and technology.

**History**

1996 First approach by US operators to the regulators (MMS & USCG) concerning approval of FPSOs in GoM;

1997 Studies started by two operators on the use of an FPSO in GoM. Ultimately one development was non commercial and the other decided to use a semisubmersible as the development solution;

1998 Start of DeepStar funded work on an Environmental Impact Statement by MMS, with USCG support, for approval in principle to enable FPSOs to be in operators’ development “toolbox”;

2000 One operator considered FPSO and FSO solutions for a GoM complex but the regulatory position was not clear, competition was close and another system was chosen in mid 2001;
2001  In December MMS issued the Record of Decision approving use of FPSOs and shuttle tankers in US waters;

2002-2005 Despite all the earlier efforts, very little operator interest in FPSOs for GoM;

2006  Petrobras and partners announce plans for first FPSO at Cascade/Chinook;

2007  Bids were solicited for the third FPSO in GoM - and first on US side - for a minimum lease of five years. Stiff competition, contract signed with BW Offshore;

2010  BW Pioneer to enter service.

Notes:
(a)  The first two FPSOs in GoM were in Mexican waters:
   1st FPSO 1989  Owned by Pemex
   1st FSO 1998  Charter from Modec
   2nd FPSO 2007  Charter from BW Offshore

(b)  For service in US waters FPSOs can be owned and built anywhere. In contrast shuttle tankers must be owned, built and crewed in US.
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
U.S. Department of the Interior
Minerals Management Service
Gulf of Mexico OCS Region

New Orleans
January 2001

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

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

Carolina U. Kallaur
Associate Director for Offshore Minerals Management
January 2002: MMS Announces “Open for FPSO Business”

Note the expected areas for FPSOs and the lightering areas
Marine Safety & The Valdez Syndrome

Oil spills from tankers still loom large in the US public mind - but simple prescriptions are available to prevent nightmares!

Marine industry best practices are very safe - hundreds of millions of barrels “on the water” every day worldwide, about 6 mmbbl/day imported into US.
The Two Linked & Ongoing Debates: “The Coming Shoot-out at the LT Corral”

**Transportation Choices**
- Pipeline
- *OR*
  - Shuttle Tanker *OR* FSO + Shuttle Tankers
    - *OR* Hiloadd + Conventional Tankers
*But*: Aggregation risks:
  - + Lining up multiple developments for an area wide pipeline export system is tough, a risk;
  - + Incrementally easier with tankers.

**AND**: **Facility Choices**
- Semisubmersible or Spar
  - + Drilling from the Platform
  - + Mostly dry trees with a few subsea tiebacks
  - + “Fixed” platform
- *OR*
  - FPSO
    - + Disconnectable
    - + All subsea completions
The Two Linked & Ongoing Debates: Facility and Transportation

**Facility**  Two main options:-

(a) Semisubmersible or Spar  
Not disconnectable  
Without storage  

(b) FPSO  
Disconnectable  
With storage  
Example: *Cascade/Chinook*  
Enter service 2010
Probable FPSO Locations
Lower Tertiary Discoveries in WR & KC

Transportation: Existing pipelines come close to some discoveries; Shuttle tankers can easily reach all locations.
Shipping lanes are already well travelled by lightering tankers.

Many pipeline breaks occurred in the 2005 hurricane season - in an emergency shuttle tankers could deliver to East Coast refineries, e.g. Philadelphia.
US law requires shuttle tankers to be Jones Act compliant:
- US built, 75+% US owned,
- US crewed,
and OPA 90 compliant (double hull);

Port drafts dictate maximum 40 ft. draft, hence maximum of about 550,000 bbl capacity;

Current limited market for shuttle tanker service demands backup trade, hence use of tankers that can work in the products trade, i.e. about 330,000 bbl capacity.

Additional features:
- Bow Loading System,
- Added maneuverability for maximum safety: CPP / Thrusters / DP2
Two time charters signed August 2007 by Petrobras America with OSG America for shuttle tanker service at *Cascade/Chinook*.

<table>
<thead>
<tr>
<th>Region</th>
<th>Typical capacity, bbl</th>
<th>Constraint on where built</th>
<th>Max. draft at port</th>
<th>Design features</th>
<th>Hold off tug?</th>
</tr>
</thead>
<tbody>
<tr>
<td>North Sea</td>
<td>up to 1,000,000</td>
<td>None</td>
<td>No limit</td>
<td>DH, BLS, DP2</td>
<td>No</td>
</tr>
<tr>
<td>US GoM at <em>Cascade/Chinook</em></td>
<td>340,000</td>
<td>US only</td>
<td>40 feet</td>
<td>DH, not DP, but bow thrusters, CPP</td>
<td>Yes</td>
</tr>
</tbody>
</table>

Despite their small size, “low tech” design and relatively short charter period, shuttle tankers in GoM proved competitive economically.
The Merchant Marine Act of 1920 (The “Jones Act”)  

Senator Wesley Livsey Jones (1863-1932), Republican from the state of Washington, author of the Jones Act, intended to protect his state’s trade with Alaska. Jones served five terms in the House of Representatives and then 22 years in the U.S. Senate.

a. The Jones Act applies to ships engaged in coastwise trade: a production platform is considered a US port, not subject to the Jones Act.

b. From the protectionist era of the 1920s, through wartime objectives, the Jones Act has evolved in 2009 to have a powerful alliance of lobbies, e.g. shipyards, ship owners, pipelines, truckers, railroads, unions.

c. There are attempts about every ten years to do away with the Jones Act - it is said to cost the country $10billion per year - but none has succeeded. Last attempt was in 2001 by Senator John McCain, trying to eliminate waste in the marine industry (Marad and Jones Act).
“America needs a strong and vibrant US Flag Merchant Marine. That is why you ... can continue to count on me to support the Jones Act (which also includes the Passenger Vessel Services Act) and the continued exclusion of maritime services in international trade agreements.”

Barack Obama, August 28, 2008

“The United States needs a maritime policy tailored to 21st century needs. Programs that have contributed to the growth of our domestic fleet, such as the Jones Act ... should be maintained.”

President George W. Bush, 2004

“My Administration ... continues to support the Jones Act as essential to the maintenance of the nation's commercial and defense maritime interests.”

President William J. Clinton, 1997

“Sealift is essential to both executing this country’s forward defense strategy and to maintaining a wartime economy... . [T]he U.S.-owned commercial ocean carrier industry ... will be relied upon to provide sealift in peace, crisis and war.”

President George H.W. Bush, 1989
Limited US Commercial Shipbuilding Capacity

Traditionally US commercial shipbuilding has been very expensive (2.5+ times Far East) and that is still true in 2009.

Delivery time has historically been unreliable and usually late.

In 2008-2009 that has all changed at Aker Philadelphia shipyard: a complete yard rebuild, plus changes in management of operations down to shop level with full labor cooperation.

US built tankers can now be delivered on a schedule set years in advance, to the nearest week, just like Korea: important for offshore production.
Shuttle Tankers in GoM - History

Demand Side
2000-2001 Consideration of FSO, FPSO and shuttle tankers for *Mardi Gras* complex;
2002-2006 Several inquiries for shuttle tankers in competition to existing pipeline offerings. *Magnolia* and *Perdido* were the most serious. Word on the street was that shuttle tankers helped oil companies hammer down the pipeliners’ rates!
First competitive bidding for *Cascade/Chinook* development.

Supply Side
2001 Conoco’s Seahorse Shuttling LLC formed;
2001 Navion Shuttle Tankers from North Sea “tests the waters”;
Navion/Skaugen form American Shuttle Tankers LLC;
2005 Teekay completes acquisition of American Shuttle Tankers, then in effect abandons this business;
First time charters for 5+1+1+1 and 4+1+1+1 for shuttle tankers.
2010 First shuttle tanker enters service in US GoM.
The closest to “rocket science” in the FPSO business

Like North Sea, US GoM operations employ shuttle tankers on short trips from FPSO to refineries and back.

Shown is back up hawser mooring to shuttle tanker while loading (black hose)
Applicable FPSO Configurations in GoM
Full Field Development (FFD)

Spread moored, risers over the side, converted tanker (NO)

Custom built newbuild, shown with external turret (YES, disconnectable)

Converted tanker with internal turret (YES, disconnectable)
FPSO Configurations for GoM: Extended Well Test (EWT) or Early Production System (EPS)

Dynamically positioned hull (thrusters fore and aft), single drillpipe riser in moonpool for EWT service.

Example: *Seillean* offshore Brazil, 1990 to date.

Moored hull via internal turret, multiple risers via turret, possibly aft thruster, for EPS service.

Example: *BW Pioneer*, 2010 in GoM
a. In 2001 the EIS assumed permanent mooring of FPSOs;

b. A DeepStar paper at OTC in May 2005 had talked of permanently moored FPSOs in GoM as “state of the art”. Never again!

c. In 2005 along came hurricanes Katrina and Rita, wreaking wide destruction of platforms, pipelines and onshore facilities, worse than ever seen by the US offshore industry:
   + Many MODUs adrift;
   + One knocked over a TLP;
   + The idea of a MODU colliding with an oil laden FPSO conjured up disaster and nightmare;

d. Everyone agreed disconnectable FPSOs were now necessary;

e. Design codes were revised in 2007 for harsher metocean conditions;
Design Conditions at First FPSO in GoM

FPSO and systems designed for 100 year winter storm;

Disconnectable FPSO: Time to disconnect and sailing speed must be sufficient to move away from the path of a hurricane that may be born in the GoM;

Target: disconnect in <1 hr. at design wave height of 4.5 meters. Riser excursion limit may govern some disconnects.

Internal Turret

5 Free standing hybrid risers
   4 Production
   1 Gas Export line

4 Catenary umbilicals;

Tandem Offloading;

Producing from two fields;

250 miles from New Orleans.
Contracting the First FPSO in US GoM

Lease signed in August 2007;

*BW Pioneer* is due to start production at the Petrobras operated *Cascade/Chinook* development in US GoM in May 2010.

*Cascade* is 50:50 Petrobras:Devon, *Chinook* is 2/3:1/3 Petrobras:Total

*BW Pioneer* shown under construction in Singapore in 1Q09:

- + 600,000 bbl storage,
- + 80,000 bopd production,
- + Export: Shuttle tankers for oil, pipeline for associated gas.
The FPSO at *Cascade/Chinook* is an Early Production System (EPS), to gain production experience in the Lower Tertiary;

A full field development solution not yet decided, not necessarily an FPSO;

An FPSO record of 8,200 ft. water depth;

Coincident with this commitment is the first use of Jones Act shuttle tankers in GoM;

Other operators are now starting to consider FPSOs seriously for remote deep waters of GoM.
The Star of the Show - What All the Fuss is About!
So What’s Ahead for FPSOs in GoM?

Disconnectable. Run before storms like in Far East. Becomes easier to modify, expand or maintain;

Long field life, e.g. Lower Tertiary fields may produce for as long as 30-50 years, i.e. about double past field lives. Important effect on facility design and on exposure to extreme storm events;

New more remote areas of Lower Tertiary turning out to be very prospective (potential for high rates). Examples: BP’s discoveries at Kaskida in 2006 and Tiber in 2009;

Long way out, over mountainous seabeds, pipeline routes much longer, more circuitous and more expensive than hitherto (export economics may favor FPSOs);

Pressure to cut the cycle time to improve economics is countered by risks of reservoirs performing differently from expectations (timing on a firm FPSO contract less clear than before);
The Trend is Up for GoM too

Source: Douglas Westwood
Today’s Deepwater Gulf of Mexico: Exploration in Lower Tertiary Trend May be Conducive for FPSOs

Lower Tertiary trend data for Alaminos Canyon, Keathley Canyon and Walker Ridge
Miocene trend data for East Breaks, Garden Banks, Green Canyon, Atwater Valley, Mississippi Canyon

Singapore
29-30 September 2009
Lower Tertiary Block Ownership
Not a traditional line up for a frontier

Key Messages from the Lower Tertiary

i. Technical and financial risks for field developments are very high. BP’s record *Tiber* discovery in Keathley Canyon was a 35,000+ ft. well. Simultaneous drilling of an appraisal well at *Kaskida* nearby was almost as deep and $250+million;

ii. Two thirds of field development investment being in drilling changes drives development strategy more;

iii. New field development flexibility desired to mitigate these risks, e.g. can an FPSO enable an earlier and lower risk start, yet not degrade economics?

iv. Arriving at a sanctionable development solution is taking longer than often expected, e.g. *Jack St. Malo, Kaskida*;

v. Producibility risks can demand dry trees and rule out FPSOs;

vi. Export economics are more important in these remote locations;

vii. Not much chance of FPSOs in GoM other than in deep remote waters of Lower Tertiary.
Conclusions

a. There are links in US GoM between reservoir conditions, well established extensive pipeline infrastructure and the choice of development solutions other than FPSOs;

b. Fields that are particularly remote, with uncertain reservoir conditions, might favor another EPS such as BW Pioneer.

c. Operator risk and field development philosophy is a factor, e.g. compare Chevron and Petrobras: Jack St. Malo and Cascade/Chinook;

d. Some field development solutions in US GoM have got accepted more quickly than FPSOs, e.g. Spars and TLPs. Curiously these two have been slow to catch on elsewhere in the world;

e. Despite the ebb and flow of business since the 1940s, GoM based oil companies do remain a key influence in the worldwide market, and do seriously contemplate FPSOs for outside GoM waters;

f. FPSOs are now considered more than ever for GoM, but another FPSO after BW Pioneer is not a sure thing.
Thank you

Questions?

For more on the documents, presentations & history leading to the acceptance of FPSOs in GoM this link can help:
www.lovie.org/fpso.html

Similarly for more on shuttle tankers in GoM, please refer to:
www.lovie.org/shuttle.html

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