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Gulf of Mexico

FPSOS ENTER THE GULF OF MEXICO OPERATOR TOOL BOX

Peter Lovie, Independent Consultant

Editor's note: This is the second of two articles on the technical challenges and regulatory hurdles that were overcome to allow the use of floating production, storage, and offloading vessels (FPSOs) in the US Gulf of Mexico (GOM). The FPSO that will be installed at Petrobras' Cascade/Chinook development in the deepwater GOM is planned for mid-2010 startup.

As 2006 progressed, teams of operators' engineers continued deliberations on how to make a start on producing two US Gulf of Mexico (GOM) field developments using a floating production, storage, and offloading (FPSO) vessel as an early production system (EPS). One team decided against it and the other agreed that an FPSO did make good sense for its field. It was an interesting contrast in the philosophies of two operators: one (Chevron) very deliberative and exhaustive, investigating all options before proceeding and only then in a tightly organized project management and planning structure; the other (Petrobras) with a more pragmatic approach, borne of the uncertainties faced in production from these untested formations and their success in Brazil in trying out production for a short period at new fields **(Fig. 1)**.

The use of an FPSO was agreed for the Petrobras-operated Cascade/Chinook development (Devon as a partner on Cascade and Total on Chinook). At multiple standing-room-only technical sessions at the 2007 Offshore Technology Conference in Houston, the offshore industry debated and settled on design-code revisions. Simultaneously, negotiations proceeded on contracting the first FPSO for the GOM, and August 2007 saw the contract signed for chartering the first FPSO in US GOM waters, for the Cascade/Chinook development. Competition had been fierce for this pioneering project.

Within weeks, two new shuttle tankers were chartered to provide export to GOM ports. This was not as simple as it sounds, as these tankers would transport oil from one US port (the FPSO) to another US port (the shore terminal or refinery) and so had to conform to the Jones Act, which stipulated that

- Crews had to be US citizens.
- The ownership of the tankers had to be at least 75% US.
- Tankers for Jones Act trade had to be built in the US.

All of the conditions translate to high capital expenditure and day rates, approximately 2–3 times that of a non-Jones Act tanker. The Merchant Marine Act of 1920 (The "Jones Act") does apply to shuttle tankers, but does *not* apply to FPSOs.

By standards elsewhere in the world, the shuttle tankers used in the US GOM are not particularly efficient—they are small (approximately 330,000 bbl capacity) to enable entry into US GOM ports with 40 ft draft restrictions, and must have alternate use in products service in US waters if the shuttle-tanker business does not continue.

Jones

Senator Wesley Livsey Jones (1863–1932) was a Republican from the state of Washington

During the 14-year journey of FPSO vessels to the US Gulf of Mexico (GOM), ***Peter Lovie*** *advocated the use of the FPSO and shuttle-tanker solutions as part of his work for an FPSO contractor (Bluewater for 7 years), then with a shuttle-tanker company (5 years with American Shuttle Tankers, later Teekay), and for the last 3 years with Devon Energy. The narrative in this two-part series draws from his presentations at two international FPSO conferences in 2009, from SPE workshops in 2002 and 2003, and a February 2009 paper on export economics. For more information, see www.lovie.org. After Devon's sale of US GOM deepwater properties and its ultimate exit from the offshore business, he became an independent consultant.*

and 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 US Senate. Some might call Jones a villain (if you have to pay for moving oil in Jones Act tankers) but some call him a great benefactor (e.g., US seafarer unions and shipyards).

HURRICANES HAD LITTLE EFFECT

In 2008, hurricane Ike demolished 59 offshore platforms in the US GOM compared with the 2005 experience of 66 with hurricane Rita and hurricane Katrina's 47. But it was the financial hurricanes—the record run-up in oil prices and then the world financial crisis of November—that shook the oil field and its suppliers. Nevertheless, the lease contract for the *BW Pioneer* FPSO remained solid and work continued on its conversion and construction, for a planned first oil date of June 2010.

Late in 2009, it looked like there were cracks in the confidence of development phases or, conversely, to minimize investment in the event of failure.

Operator/Development Status Late 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 August 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%

Fig. 1—Comparison of development solutions in deepwater fields in the US GOM.

Palagi

Cesar Palagi *is the Walker Ridge Production asset manager with Petrobras America, based in Houston. Palagi is responsible for the design and implementation of development projects of ultradeepwaters and Lower Tertiary petroleum fields in the Gulf of Mexico. He has provided technical and managerial E&P services to Petrobras for 30 years. He earned a degree in civil engineering from the Universidade Federal do Rio Grande do Sul, and earned an MSc degree from Universidade Federal de Ouro Preto, Brazil, and a PhD from Stanford University, both in petroleum reservoir engineering.*

The Cascade and Chinook fields are located in the Walker Ridge Outer Continental Shelf leasing area of the central Gulf of Mexico (GOM). There are no production analogs for these two fields and a phased development is justified because of reservoir uncertainties. The purpose of Phase 1 is to analyze reservoir performance to enable optimization of future project-

Cascade was discovered in 2002 and Chinook in 2003. The discoveries, among others, defined a new hydrocarbon trend in ultradeepwater GOM. The hydrocarbon-bearing sandstones are equivalent to the Wilcox Group (Eocene-Paleocene), a prolific producing sediment onshore GOM. Cascade is located approximately 160 miles south of the Louisiana coast in 8,200 ft water depth and Chinook is approximately 15 miles south of Cascade in 8,700 ft water depth. Wells will be drilled to a total depth of approximately 27,000 ft. Petrobras operates both fields.

Phase 1 will consist of two subsea wells in Cascade and one subsea well in Chinook tied back to the disconnectable turret-moored FPSO vessel *BW Pioneer*. Oil (18–27°API) will be transported from the field in shuttle vessels to terminals along the Gulf coast from Texas to Mississippi and gas will be exported through a gas-export pipeline. The minimum amount of infrastructure will be installed in Phase 1; however, the development concept is flexible and enables multiple development scenarios in future phases and up to 80,000 BOPD of production. Besides the FPSO and shuttle tankers, two other technologies new to the US GOM will be deployed in Phase 1: free-standing hybrid risers and subsea electric submersible pumps.

The FPSO and shuttle tanker were the preferred solution for Phase 1 of development of Cascade and Chinook fields mainly because of the uncertainties on the performance of Lower Tertiary reservoirs and the lack or pipeline infrastructure in the Walker Ridge quadrant of GOM. Petrobras has deployed FPSOs to develop petroleum fields offshore Brazil since the 1970s.

While the available data was insufficient to form a basis for a full-field development at the time of the conceptual design in the second half of 2006, there was sufficient data to implement a phased-development plan with a small number of initial wells. The design and procurement of the FPSO and the subsea system was conducted in 2006 and 2007. Most of the construction and installation of these facilities were performed in 2008 and 2009. The well drilling and completion campaign started in 2008. First oil is on schedule for mid-2010.

success for US GOM deepwater developments: Statoil sold some of its interests in deepwater blocks to CNOOC, and Devon announced plans to sell deepwater assets and eventually decided to get completely out of its offshore, selling its Cascade and Jack St. Malo interests to Maersk Oil.

But 2010 has brought in a new decade with hope for better times. The first FPSO for the US GOM is complete and en route at the time this article was written. Petrobras as the operator at Cascade/Chinook has managed its way successfully through all the regulatory hurdles of the US, through changes in partners and the business climate during the journey, and has upheld its fine reputation for pioneering and being a leading user of FPSOs.

LESSONS LEARNED AND WHAT'S AHEAD

It has become apparent that FPSOs in US GOM are unlikely to be used anywhere other than in the most remote and deepwater locations—

Bozeman

W.D. (Dave) Bozeman *was vice president at Devon Energy in Houston, responsible for the Project Support Office that planned and managed major projects, before Devon's sell down of deepwater assets.*

My first exposure to the idea of the FPSO vessels and shuttle-tanker concept was in the late 1980s during my experience on a development in the South China Sea. The development was remote and far removed from pipeline infrastructure, so the idea of using a tanker to store and then transport crude to markets made a lot of sense. This concept registered with me in a profound way because the area in China was prone to cyclonic wind storms and the FPSO was designed to be disconnected and able to run from approaching storms.

Years later during my tenure with Devon Energy, this concept seemed like a near-perfect solution for developing Lower Tertiary prospects. At the time, Devon was the second-largest acreage lease holder in the Lower Tertiary area and had several real possibilities for development, both as operator and nonoperating partner. The FPSO/shuttle-tanker concept seemed to be a good fit because these prospects were far from pipeline infrastructure and developing pipelines in these water depths was prohibitively expensive. Several years of economic study seemed to show that FPSOs were economically attractive. Also, the possibility of operating shuttle tankers as "floating pipelines" seemed to some of us as a golden opportunity to monetize these tankers rather than just consider them as an operating necessity; it seemed possible to make a profit from them instead of just suffering an operating expense.

We believed that during times of low production from one development, the shuttle tankers could be redeployed, shared, or hired out to other operators at a profit. Also, the shuttle-tanker concept would give independents a strength that majors in the area enjoyed and that was infrastructure. Shuttle tankers could act as our "pipeline infrastructure" and give us a similar competitive advantage in deepwater areas.

The major drawback of the concept in the GOM is the tanker itself. Ever since the Valdez incident there has been a very real concern for the potential liability of a large oil spill due to a tanker accident whether caused by nature or man. However, there is a huge body of experience with tanker operations (both FPSO and shuttle tankers) worldwide and so it was important to perform due diligence and make sure everything was done as well as could be done in our industry. We had often joked that the method of oil export from the FPSO did not matter as long as it was safe. Whether it was done with canoes or buckets didn't matter as long as not a drop of oil was spilled and safety of the operating crew and infrastructure was not compromised.

All joking aside, it was serious business to be involved in the first FPSO/shuttle-tanker development in the US. There was not an extensive established shuttle-tanker business in the GOM such as existed in the North Sea or Brazil. Thus our partner Petrobras had a difficult task finding available shuttle tankers that would satisfy project requirements and also meet the Jones Act requirements. Also, while the concept had been tentatively approved by the US Coast Guard and US Minerals Management Service years ago, the actual procedures of approval for the first real project would have to be hashed out detail by detail.

There are many problems inherent with large development projects like Cascade/Chinook and the many others pending in the Lower Tertiary, not the least of which are cost and schedule. The majors for years have been plagued by significant project cost and schedule overruns and have worked to establish project-management systems and processes to help mitigate that. Devon recognized the need and created a Project Support Office tasked with the creation of project-management principles, systems, and tools to be used in major project planning and execution. This system, the Devon Project Management Methodology, was put in place to provide ample checks and balances during each phase of a project to minimize surprises and mitigate the risk of them when surprises did occur.

All of that effort is now moot, since Devon has sold its deepwater interests for reasons valid to its new corporate strategy. The Project Support Office was disbanded and many employees both within and outside of the office were laid off, myself included. However, several important things stand out during the journey with Devon, including:

- While Devon never used an FPSO, the concept did receive serious attention by Devon management along with several other concepts such as the spar and semi.
- Devon recognized and supported a rigorous planning and execution process, including extensive use of decision analysis that objectively compared different field-development solutions. Emphasis was put on forming cross-disciplinary teams that included geologists, geophysicists, petroleum engineers, facility engineers, and project-management experts.
- There was no prejudice among operators against using FPSOs. It was a long journey to the first one, but it was only a matter of time and finding the right application.

A representation of the first FPSO in the US GOM: the *BW Pioneer*, owned by BW Offshore, on charter to Petrobras America.

there are other development solutions that make more sense overall. But it is often taking longer than it did just a few years ago to arrive at a development solution for these remote locations, for example, the Jack St. Malo and Kaskida fields. The debate continues about whether to use an EPS or not. Pressure to cut the cycle time to improve economics is countered by risks of reservoirs performing differently from expectations.

Export economics are more important in these remote locations. Shuttle-tanker export may indeed offer an economic benefit over pipelines, even for large fields in the remote ultradeepwaters of the GOM (e.g., the Lower Tertiary) where it can be in the order of a billion dollar savings over field life at locations a long way out or in mountainous seabeds where pipeline routes are much longer, more circuitous, and more expensive.

But can one reliably depend on remote field developments producing from unproven formations? Producibility risks and the need for frequent well interventions can demand dry trees and rule out FPSOs. Fields that are particularly remote, with uncertain reservoir conditions, might favor another EPS for an initial period such as Petrobras' initiative with *BW Pioneer* at Cascade/Chinook.

So there is no clear advantage that favors FPSOs in the US GOM in the future—it comes back to a case-by-case debate. There is no clear demand trend for FPSOs in the US GOM as there may be for other parts of the world, such as west Africa. But unlike 14 years ago, when the journey toward using FPSOs in the GOM began, they are now considered as a serious tool in the operator's tool box. **JPT**