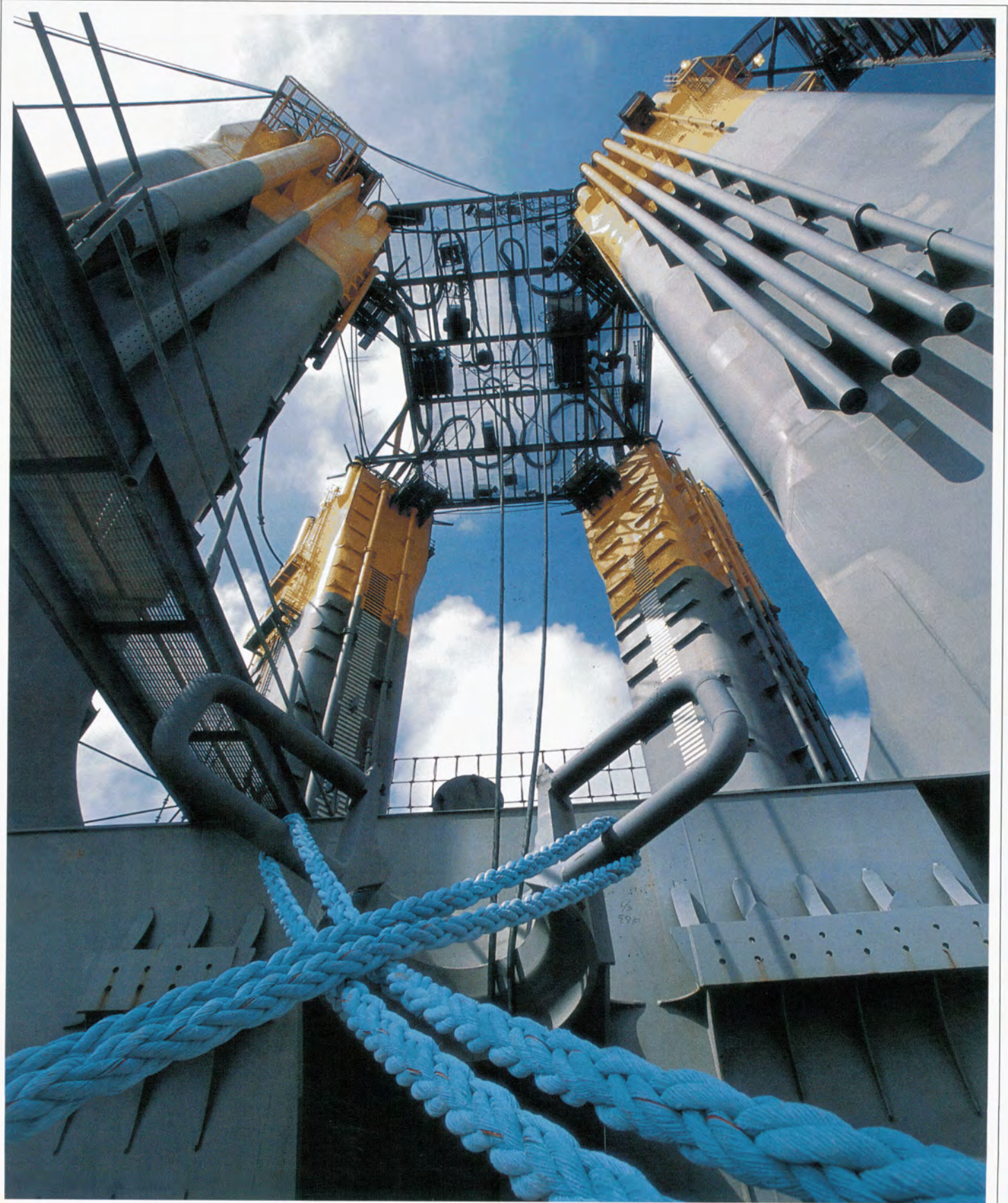


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Infrastructure needs in the deepwater Gulf are giving rise to innovation.

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GULF OF MEXICO

Better production technology and clever ways to finance hub facilities are making the deepwater Gulf's potential more likely to be fulfilled.

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PHOTOGRAPHY BY
LOWELL GEORGIA

A discussion of infrastructure in the Gulf of Mexico doesn't sound exciting compared with billion-barrel discoveries or thrilling technologies that allow companies to drill in 8,000 feet of water. But increasingly, production infrastructure will be a key to unlocking the Gulf's deepwater potential.

Operators and vendors are paying more attention to infrastructure issues as they venture farther from shore. They are weighing the pros and cons of pipelines versus shuttle tankers versus floating production, storage and offloading vessels (FPSOs), the latter having been cleared by federal agencies for use.

The oft-cited Outer Continental Shelf production declines, while all too real, are not the whole story in the Gulf. Neither is the fact that drilling activity offshore is flat with last year. If one considers what's going on in development, where huge investments are required, then the Gulf has been very busy. Wells announced with a great deal of fanfare in recent years are finally coming online.

"Discoveries are always more exciting than development," says Dan Pickering, managing director of energy investment-banking firm Simmons & Co. International, Houston. "The thing is, we're in a period of putting the discoveries into the sales line. Production is creeping up now, and is set to really go up, such as when BP's Thunder Horse comes online in 2005." The field and its satellite, Thunder Horse North, contain 1.5 billion barrels of recoverable oil, the largest oil complex found yet in the Gulf of Mexico.

"The promise and the excitement of 2000 are starting to play out."

Just in the past few months, work has advanced rapidly for some projects whose production comes onstream this year and next. Twenty-six deepwater platforms are on location and producing, and another 13 are under construction or being installed. Atlantia Offshore Ltd. just installed seven production risers for Total E&P USA's Matterhorn Field. This tension-leg platform (TLP) is the latest and largest of four consecutive on-budget SeaStar TLPs to be delivered by Atlantia, a division of IHC CaLand based in Houston.

Global Industries Ltd. has been laying pipe for Kerr-McGee's Gunnison Field, which comes onstream in first-quarter 2004, building

to a peak of 180 million cubic feet of gas and 30,000 barrels of oil per day by year-end. The operator's Red Hawk spar is under construction and will come onstream in the second quarter. And Kerr-McGee is completing additional wells to tie into its Nansen-Boomvang spars.

Production at Dominion Resources' Devil's Tower spar, originally scheduled to come onstream this year, will slip to first-quarter 2004. The topsides were to sail out to location this month, to Mississippi Canyon 773.

Torch Offshore Inc. of Gretna, Louisiana, recently recorded an industry first in the deepwater Gulf—the company recycled 43,000 feet of double-armored subsea control umbilical lines from the Mustique Field. The umbilicals will be redeployed at Mariner Energy's Ochre project in Mississippi Canyon for a one-well tieback to MC Block 20.

These projects are part of a coming surge in deepwater production. According to the Minerals Management Service (MMS), 81 deepwater fields will be producing by the end of 2003. Another 15 will come onstream next year; six of these will be produced from spars.

MMS estimates that by 2006, deepwater oil production will have grown at least 33% from today's level. IHS Energy says that in the next

Infrastructure is driving the deepwater Gulf of Mexico today, says Robert G. Phillips, chief executive of GulfTerra Energy Partners LLC. Facing page: At the yard near Corpus Christi, Texas, the Marco Polo tension leg platform's hull is ready to be towed to deep water for Anadarko Petroleum Co.

PHOTO BY DAN YOUNG, EL PASO CORP.





CAUTION
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Deepwater Gulf gas production grew from 1 billion cubic feet a day in 1996 to 3.7 Bcf in 2002. Estimates are 4.3- to 6 Bcf a day will be produced in 2005.

three years, deepwater gas production may add as much as 3 billion cubic feet per day to supply, offsetting declines in shallower water.

In a Society of Petroleum Engineers (SPE) paper given at this year's Offshore Technology Conference, GulfTerra Energy Partners' Bart Heijermans and Drew Cozby said the Houston master limited partnership is tracking 75 active deepwater prospects, including sanctioned projects. These have estimated risked reserves of 4.5 billion barrels of oil equivalent (BOE). The capital required to develop these could be up to \$28 billion, they said.

"Infrastucture, or lack thereof, is what's driving activity now. We're at roughly 40- to 45 billion BOE from 11,000 discoveries in the shallow water, but the deepwater trend is still very early in its development," says GulfTerra chairman and chief executive Robert G. Phillips. "There will be significantly more reserves there, on the order of 60 billion BOE, so we're excited about the long term.

"We're beginning to see a faster timeline between discovery and production, and smaller independent operators are moving into deep water, largely because there is more infrastructure present."

Quest Offshore Resources projects \$37.8 billion of capital expenditure from 2003 through year-end 2006 for announced deepwater projects. "This represents more than a two-fold increase in growth from 1999 through 2002," says president Paul Hillegeist. "This is fueled primarily by increasing subsea tieback opportunities to new and existing hubs, which in turn is propelled by accelerated growth of new deepwater infrastructure since the mid-1990s—a snowball effect if you will.

A network of pipelines is developing along the deepwater-shallow water boundary.

New Deepwater Gulf of Mexico Gas Production

2003-2005*

Project/Operator	First production	Peak rate (MMcfd)
Boris/BHP	2/03	30
Falcon's Nest/Pioneer	3/03	300
Matterhorn/Total	9/03	55
Medusa/Murphy Oil	10/03	110
Na Kika hub/Shell, BP	10/03	425
Princess/Shell	12/03	200
Marco Polo/Anadarko	1Q/04	150
Devil's Tower/Dominion	1/04	60
Gunnison/Kerr-McGee	3/04	200
Front Runner/Murphy	6/04	110
Red Hawk/Kerr-McGee	6/04	120
Magnolia/ConocoPhillips	12/04	70
Mad Dog/BP	1/05	40
Holstein/BP	3/05	90
Thunder Horse/BP	3/05	200

* Several of these fields also will produce oil. Source: MMS, company news

"We are tracking 52 floating units—whether spar, TLP or floater. Fourteen are under construction and 38 are being evaluated or moved from appraisal to development, just prior to tendering for bids. Some of these go out to 2008."

The Houston company's forecast is comprised of large floating production systems and subsea tiebacks. Hillegeist says about 60% of the single-well projects, and a rising number of small floating platforms, will be executed by independents, while the majors focus on large FPS projects.

Whatever the project size, with the slow-down in drilling every single well that comes online becomes that much more important. This is a time when more companies are trying to





From left, a deepwater observer, infrastructure provider and operator: analyst Jeff Mobley of Raymond James & Associates, Bart Heijermans, vice president of GulfTerra Energy Partners LLC; and Anadarko Petroleum Co. vice president Mark Pease.

drill very expensive deep-shelf gas prospects, or explore the frontier eastern Gulf of Mexico, where dry-hole costs on a single well can be up to \$40 million—enough to daunt all but the most financially stout producers.

When operators focus on large projects with longer lead times, their activity is apt to be less cyclical even though commodity prices change, says E&P analyst Jeff Mobley with Raymond James & Associates. “For example, the Front Runner Field, owned by Murphy Oil, Dominion Exploration & Production and Spinnaker Exploration, was discovered in 1999 but will come on in mid-2004. It’s a spar with eight wells tied back to it. That was a long lead time, but drilling those eight wells has been done fairly steadily all along.”

Front Runner’s spar can produce 60,000 barrels of oil and 110 million cubic feet of gas a day from three fields. Estimated total reserves are 150 million BOE.

Hub and spoke

In addition to tackling ultradeepwater challenges of distance, temperature and pressure, the industry is developing more economic means of producing smaller and marginal fields. The hub-and-spoke concept fits the bill, and especially if a midstream company enters the picture so operators absorb less infrastructure cost.

Many operators use the hub concept to develop their satellite fields. This past March, Pioneer Natural Resources brought on its Falcon gas field in East Breaks 579/623 in 3,450 feet of water. Ultimate recoverable reserves are an estimated 125 billion cubic feet. Production from the Falcon gas field is being processed on a shelf-based hub platform, dubbed Falcon’s Nest, owned by GulfTerra. This platform will also serve subsea wells from nearby Harrier, Tomahawk and Raptor fields, which will be tied back in 2004.

“Falcon’s Nest is typical of the momentum common to these projects—wells there will deplete but they have eight or 10 more wells to drill

and tie in behind those,” Hillegeist says.

A far larger example lies in Mississippi Canyon where Shell and BP jointly own Na Kika. This is a native word for octopus, which makes sense when you see schematics of the project. Long tentacles (subsea umbilicals) wind from subsea wellheads to the host facility—a permanently moored, floating, semisubmersible-shaped hull with topsides that will process oil and gas from six small- to medium-size fields.

Na Kika was set in place earlier this summer. It has already set a number of firsts: it is Shell’s first semisubmersible host facility in deep water, and the deepest permanently moored floating oil and gas development system in the Gulf, in 6,300 feet of water. It uses the first gas-lift production risers in the Gulf and the first pipe-in-pipe risers in the world.

The facility will be able to process 425 million cubic feet of gas and 110,000 barrels of oil per day. First production is scheduled by year-end or early in 2004.

Marco Polo

At press time, GulfTerra was in Green Canyon 608 hooking up the massive Marco Polo tension leg platform, the largest TLP in

Deepwater infrastructure is massive. Here, two McDermott International crane barges lashed together to lift the 5,300-ton topsides of Kerr-McGee’s truss spar onto the hull at Nansen Field in the East Breaks area.



Spending on floating production systems and subsea tiebacks could reach \$37.8 billion by 2006.

terms of total productive capacity. It is to come online in 2004, and it is also in some of the deepest water—some 4,300 feet.

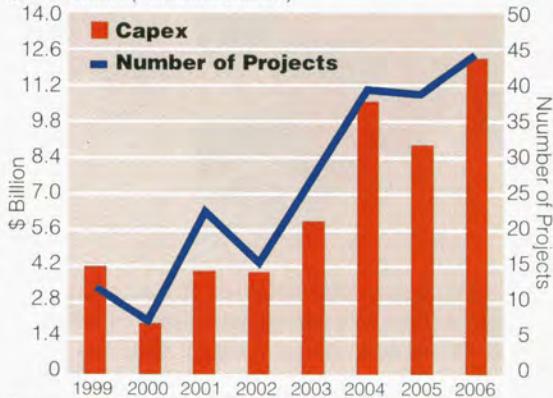
First production begins in March, ramping up by year-end to produce 45,000 barrels of oil and 30 million cubic feet of gas per day, from six wells, for Anadarko Petroleum Co., according to Mark Pease, Anadarko vice president, onshore and offshore. But there's more.

"We supersized the TLP so Anadarko has the capacity it needs, but we added excess because this Green Canyon area is one of the most prolific in the Gulf of Mexico," says Bart Heijermans, GulfTerra vice president, offshore.

The TLP's capacity is about double

Gulf of Mexico Total Deepwater Market Capex

\$37.8 Billion (Forecast 2003+)



Source: Quest Offshore Resources Inc.

WHY THE SLOWDOWN?

It's been fashionable to lament the slow drilling pace in the Gulf of Mexico this year. Since January the U.S. rig count has increased by about 240 rigs, but 245 of those were onshore—meaning the offshore count fell. In September, the offshore rig count was 6% lower than in the same period of 2002.

This fall at least half a dozen rigs left for Mexican waters to work for Pemex or to work offshore Africa. A few contractors also removed from service some of their older iron, further reducing the number of marketable rigs. Day rates have been mediocre all year, still averaging about 30% lower than in early 2001, the last peak period, with the exception of some premium jackup rigs.

Slow rig counts in the face of production declines and high commodity prices have people puzzled. That's why a number of large projects coming on stream this year and next are being watched with such interest. But will there be enough deepwater production to offset declines?

"People look at these large, high visibility projects such as Total's Canyon Express, which last fall brought on half a Bcf of gas a day, and they forget the decline that is occurring elsewhere in the Gulf," notes Marshall Adkins, managing director of energy equity research for Raymond James & Associates. "We know, for example, of a platform of a very large independent that came on stream in 1998 making 120 million cubic feet a day, but five years later it is down to 20 million a day."

Many think the conventional Shelf plays are pretty well picked over and they look to the Deep Shelf and deep water to increasingly make up for those losses.

"The technological-exploitation aspect of the business has matured. For example, 3-D is not the hot new thing, it is well-implemented. So the low-hanging fruit that companies picked in 1995 is gone," says

managing director Dan Pickering of Simmons and Co. International. "The acknowledgment of that shows up in the players looking at the deep gas play. And a lot of companies blew through their prospect inventories in 2000 and 2001. Now they get to spend time developing new prospects, and by the way, 2002 prices blew up [causing them to be more cautious]."

Colleague David Purcell adds that as a result of many mergers, drilling activity in the Gulf of Mexico may have slowed a bit during the "digestion" period, and some of the M&A promise has been disappointing.

"Companies have to do more true G&G work now [geological and geophysical] in lieu of buying opportunities. They have to take on more risk to attack the basin. And as the average prospect size declines, the risk profile has to go up. Also, there are fewer low-risk development wells associated with each exploration success—it is not uncommon to have one- or two-well fields."

Purcell says the real story is the falloff in the majors' concentration in the Gulf. From a peak rig count of about 70 rigs in early 2001, the majors today have only 20 rigs working in the Gulf. "It's a question of strategy and materiality—do you want to work hard to find 5 Bcf or 250 million barrels?"

This activity gap is being filled by the independents to be sure, but a typical company of that size isn't likely to maintain a big program like a major would, say, 10 rigs running for 10 months in a row.

"We've learned that it is difficult to add supply and it is easy for supply to fall. The answer so far is to reduce demand through a high price—but that is not much of a model for growing a business," says Pickering.

The deepwater challenge is not technology or capital so much as it is supply development risk, observers say.



Marshall Adkins, head of research for Raymond James & Co.

Facing page: Heerema's Hermod crane barge lifts the topsides for Kerr-McGee's Boomvang spar in April 2002. Overleaf: In mid-November, the five-story, 6,400-ton Marco Polo topsides were to be placed atop the hull "legs" (shown on the cover), on Green Canyon 608. Installation of the galley, furniture, electrical and instrumentation systems was done in October.

PHOTO BY MIEKO MAHI







Painters put the finishing touches on Marco Polo's helideck.

Anadarko's immediate needs as it can handle 120,000 barrels of oil and 300 million cubic feet of gas per day. This allows GulfTerra to aggregate production from other producers nearby and helps Anadarko justify developing its smaller, satellite fields in the region as well.

There is another benefit. GulfTerra and partner Cal Dive International each own 50% of the TLP, but Anadarko will operate it, meaning the latter's upfront investment on infrastructure was nil. This is the first time Anadarko has made such an arrangement, always having built and owned the infrastructure itself in the past.

The Marco Polo wells were drilled under budget, Pease says, and the company found more productive pay than was forecast, making the entire project more economic.

"When we first started talking about this [TLP arrangement], it was a new idea for us. As we dug deeper, it became clear it was a good idea. I'll be real surprised if we don't see a similar arrangement in the eastern Gulf," says Pease.

There, Anadarko and Kerr-McGee Corp. have several discoveries on the recent Lease Sale 181 blocks.

GulfTerra has made the offshore arena a cornerstone of its business, which also includes a strong presence onshore in oil and gas pipelines, gas storage and processing, and other midstream businesses. It gathers almost 1 billion cubic feet a day of deepwater gas. By 2005 it will be connected to or have access to 50% of the deepwater platforms in the Gulf, by virtue of its pipeline system, says GulfTerra's Phillips.

"Installing infrastructure and oversizing it accelerates development time," he says. "We can process oil and gas on the platform, move it to shore or process it there. This has a cumulative effect—as we lay more pipelines and infrastructure out there, we will see independents able to advance their plans and they can conserve their capital."

It worked for Anadarko. Pease says, "Because we could share the cost of the facility development with other producers, we didn't have to put as much money up front, and that capital could be used for drilling. They paid for building the TLP and we'll pay them a processing fee and demand charge as we produce the field."

"We have other blocks in the area, so we hope to have discoveries there, and we can accelerate their development." Anadarko made the K-2 discovery in August 2002 about five miles away. (Agip operates, but Anadarko has 52.5%.) And at press time it was drilling the first well at Green Canyon 518, which is to the north and of which it owns 100%.

GulfTerra's new crown jewel is the Cameron Highway Oil Pipeline, a 380-mile system from deep water to shallow that begins service in the western Gulf in 2004. It is the company's biggest greenfield project yet, with capacity for 500,000 barrels of oil a day. Valero Energy is a partner. This \$460-million pipeline system will enable BP, BHP and Unocal to access Texas re-



fineries for their new deepwater production.

Kerr-McGee continues to exploit the capacity of its infrastructure as well. In deep water, its two truss spars, Nansen and Boomvang, are just nine miles apart in the East Breaks area about 150 miles south of Houston. The spars began production last year.

This year the company will bring on another 34,500 barrels of oil equivalent per day (gross) from additional wells at Nansen, Boomvang and nearby Northwest Navajo and West Navajo fields. It's all part of a strategy of clustering prospects around infrastructure to create core areas. It has 24 blocks in the Nansen-Boomvang area.

"In 2004, we'll turn our attention to Gun-nison, our third truss spar, which comes on in the early part of the first quarter, and to Red Hawk, our first cell spar, which comes on during the latter part of the second quarter. And we are still completing satellite wells that will be tied back to Nansen and Boomvang," says Dave Hager, Kerr-McGee senior vice president, oil and gas. "The new wells there keep the peak production rate at a plateau instead of increasing production."

The Red Hawk spar, co-owned by Devon Energy, will be set in Garden Banks 877 in 5,300 feet of water. It is a series of nine 20-foot diameter tubes. Since the tubes are smaller in diameter than the one-piece truss spars, they are easier and cheaper to fabricate, Hager explains.

Reserves are an estimated 240 billion cubic feet of gas. Production will be 120 million cubic feet a day and will be gathered by a new pipeline built by GulfTerra.

"Because we've lowered the cost of the production facility, we've made a stand-alone field in deep water more economic," Hager says. "We had the option to tie back to other compa-



Kerr-McGee Corp. senior vice president Dave Hager says infrastructure helps the company exploit its deepwater blocks.



The hull of the Marco Polo tension leg platform designed by Modec, and built in South Korea by Samsung, arrived at Kiewit Offshore Services' yard in Corpus Christi, Texas, this summer.

nies' platforms or to one in which we had an interest, but the economics for the cell spar were so compelling we decided to go that way. Now we can potentially tie in smaller accumulations and it could become a hub."

Technology's role

"We've seen dramatic improvement in technology for deepwater drilling and completion, but also for pipelines and platforms. At the time of installation, Marco Polo will be the world's deepest-water TLP," says GulfTerra's Phillips. "This historically has been the province of the major producers but the fact that an independent midstream company like GulfTerra can install this kind of TLP is a testament to how technology pervades this industry."

Hager says the importance of being able to tie subsea wells back to a host platform cannot be overemphasized. Subsea tiebacks can save up to 50% of the cost to produce new wells.

The strategy at FMC Technologies Inc., which specializes in subsea technology, is to create long-term, preferred-vendor relationships with the most active offshore players. It has a five-year contract to supply BP subsea components throughout the Gulf, including at Thunder Horse and Na Kika. It has similar arrangements with Shell and Kerr-McGee, among others. It also has a joint venture with Halliburton for subsea well intervention.

One goal is to bring lessons learned from one field to others. "Thunder Horse is in 6,000 feet of water and presented unique challenges the industry hasn't dealt with before," says John Grempe, division manager, FMC Energy Production Systems. "The wells have pressure of 15,000 psi and temperatures of 350 degrees Fahrenheit, hotter than normal." FMC developed a new high-pressure/high-temperature

system (HP/HT) for Thunder Horse.

A key consideration for FMC now? To standardize and ensure the repeatability of its designs so costs can be controlled and operators can expect reliability under harsh deepwater conditions. One subsea wellhead—the tree and controls, but not counting the manifold or flow lines—can cost from \$1 million in shallow water to \$5 million in HP/HT environments, so repairs are tricky and production downtime is expensive.

"We are now producing tree number 40 of a standard design we developed with Shell years ago. If an operator can get the needed equipment off the shelf, and faster, they can fast-track their development of a field, and if they need to move on project B before project A, they can," says Grempe.

The global offshore construction business has been good enough for Paragon Engineering Services Inc. that the engineering, construction and project management firm just doubled its Houston office space. President Ken Arnold owns 60% of the company and Dresser-Rand, the rest.

A major project recently involved assisting BP in evaluating how to transport its growing deepwater production. "We helped BP look at more than 100 options, doing the economic analysis and conceptual studies. A group of their engineers is housed in our building. We've been on this project for several years."

The result is the Mardi Gras system, a series of three pipelines tied back to infrastructure on the Shelf, using pipelines owned by BP and third parties, as well as new and modified platforms for compression and metering.

Tanker, pipeline, FPSO?

A debate is brewing among deepwater opera-



Peter Lovie, vice president of American Shuttle Tankers, thinks shuttles are a viable alternative to pipelines in some cases.



Above, signal flags of the 910-foot-long aircraft carrier U.S.S. Lexington. She was decommissioned in 1991 after serving in the Pacific during World War II and serving for 30 years as a naval training vessel at San Diego and Pensacola. She is now a museum, permanently docked in Corpus Christi.

tors and vendors over the safest, most economic method to bring significant new production to shore. The industry's 12-operator deepwater consortium, DeepStar, has added transportation issues to its mission statement for the first time in 12 years of research. About 80% of all deepwater leases are held by these 12 firms.

Traditional pipeline systems that are stretching farther from the beach may be challenged by a new concept for the Gulf—shuttle tankers. The pros and cons of tankers justified a day-long workshop at press time, sponsored by the facilities and construction group of the SPE's Gulf Coast Section.

"We have a very efficient pipeline system and there hasn't been a need for competition until now. But the technology and economics of deep water is more complicated, so tankers have a better shot," says Peter Lovie, vice president, business development, American Shuttle Tankers, and chair of the SPE workshop. "It's quite a new game. The stakes are high so people are asking more questions."

The Houston company was formed in 2001 to bring dynamically positioned tankers to the Gulf from the North Sea. It is owned by the largest tanker company in the North Sea, Navion, which is a unit of NYSE-traded Teekay Shipping.

"We see oil companies preferring pipelines, but I think shuttling will be a viable option, and for some plays it may be the only one," Lovie says. His reception by operators has been one of curiosity tempered with some hesitancy as they recall the Exxon *Valdez* tanker disaster in Alaska in 1989.

With tankers, however, a new degree of flexibility is possible. The operator is free to sell oil to any port or refinery in the Gulf—indeed the world—to maximize return as markets change. And, he is not tied to one pipeline offering an average price for all the crudes that go into it. If the crude is of premium quality, it can command a premium price if it moves by tanker, Lovie says.

"Based on our studies and those of DeepStar, the economics are very site-specific," he concedes. "If the field is near an existing pipeline that has been operating for some time, the tariff is very competitive. But if the oil is much deeper, and located farther out, transportation is generally favorable by tanker."

By using a tanker, the producer doesn't bear the huge upfront investment of platform construction. Instead, transportation is an operating cost based on a fee per barrel.

As industry ventures deeper, in many cases it is more economic to tie back subsea wells instead of building a new platform with surface wellheads, says Kerr-McGee's Hager. "Every field is different, and there are limits. In general, oil can move about 15 miles by pipeline in deep water, whereas gas can go 50 or 60 miles."

"In the southernmost part of Alaminos Canyon, Shell has made the Great White dis-

covery and Unocal has its Trident discovery. But it's out in the middle of nowhere, so operators will have to look at a lot of options," says Quest's Hillegeist.

"They may have to cooperate as they did with the Mardi Gras transportation system, a venture between BP and Shell." Mardi Gras, a system of three pipelines, comes into service in 2004 and will tie into BP's Thunder Horse in 2005.

Floating production, storage and offloading vessels (FPSOs) and shuttle tankers were approved for the Gulf of Mexico in late 2001, but the MMS has yet to receive any application for them. For many fields, fabrication of an FPSO is simply too expensive. Then too, as the amount of deepwater infrastructure expands, the need is reduced for a stand-alone system like an FPSO, says Hager.

"The need to shuttle the oil is greater than building an incremental pipeline to deep water, but what are you going to do with the gas?"

The MMS does not allow gas to be reinjected or flared, except on a temporary basis—it has to be produced eventually. And no company can afford to hold up production of its oil field for long, while it figures out how to handle the associated gas.

That's where another idea is taking shape, to build new vessels that support compressed natural gas (CNG) storage. That way the gas can be transported to shore.

"There is a lot of opportunity for CNG transportation," says Paragon's Arnold, "especially if we develop reserves far out. We'll tanker the oil, but rather than install a gas pipeline, we'll use CNG."

Paragon did a lot of engineering study for EnerSeas, a Houston start-up that wants to bring CNG transportation to the Gulf. In some circumstances, this method will be more economic than liquefied natural gas (LNG) or gas-to-liquids (GTL) schemes, Arnold says.

Whatever the optimism in the longer term, offshore players know the cycles of offshore-infrastructure spending will ebb and flow. "The contractors are a little worried about the next phase, because so many projects are nearing the end of their construction phase and entering the commissioning phase," says Hillegeist.

"2003 has been a little slim on contract awards, but there are some coming for tender in 2004 that will come onstream in 2006, like ChevronTexaco's Tahiti Field. Five or six projects are gaining momentum for 2006."

Discoveries have been made in deep water that appear uneconomic at this time, or that present great challenges because they are so far from shore or in such deep water that there is a lack of the right infrastructure.

"There is no one answer—spars, TLPs, shuttle tankers or FPSOs," says Arnold. "The future is not a constant, but will come in waves. Right now we are in a wave of construction and installation." □



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