Delta House
A new hub in Mississippi Canyon
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We earn our money through the drill bit. Our strength is exploration. LLOG geoscientists—mostly former employees of some of the world’s largest oil producers—have a level of experience not seen in many companies our size. Working from the biggest available data sets, our geoscience team develops an understanding of the reservoir that is second to none. It’s not a claim we make lightly. The success of Delta House is just the latest example of their skill at finding oil.

Mississippi Canyon is one of the most prolific oil and gas regions in the Gulf of Mexico, and thanks to our lease acquisition team, we have a healthy position there.

Our Who Dat field, discovered in 2007, has been a steady producer since 2011. Delta House builds on that success. While every deepwater project has its own unique challenges for the entire project team, Delta House is a showcase of who we are and what we can do.
The Project Takes Shape

A model for development in the Gulf of Mexico

The Delta House deepwater floating production system (FPS) and its subsea infrastructure are parts of a field development plan that has been one of the most efficient in the industry. Delta House Phase One taps three Mississippi Canyon fields where the average water depth is around 4,500 feet and reservoirs range from 12,000 to 18,500 feet. First oil is expected by mid-2015. According to the current plan, at least four more LLOG fields could eventually tie into the host platform.

Working Against Time

In early 2010, a handful of joint venture partners were just beginning to realize the potential of their recently-acquired portfolio. The challenge was how to drill them before the 20 or so deepwater leases they’d purchased timed out. They had less than 36 months left on the clock.

The schedule would have been tough in any case, but following BP’s Macondo event, operators in the Gulf of Mexico were granted a one-time ‘presidential’ lease “Suspension of Operations” due to the drilling moratorium. While these special Suspension of Operations gave LLOG and its partners more time to study their leases, no one was sure when drilling could resume.

LLOG used the time to study the leases and pick the most valuable ones to explore. While we weren’t able to drill in time to save all the leases, we did save the ones that we felt were...
most important,” says Rick Fowler, LLOG vice president of deepwater projects.

What’s in a name?

“It’s typical with a project like this to let the geologists name the reservoirs based on a common theme, like the names of mountains or rivers,” Fowler explains. “Others have used rock bands or even cartoon characters. Our guys used a movie.”

The informal naming scheme was based loosely on Animal House, a 1978 comedy about a renegade college fraternity in the early 1960s. Two of the memorable characters in the film were named Bluto and Marmalard.

“Around the office, we started calling the project Bluto,” Fowler says. “The first discovery well became Son of Bluto Two. Now we have a Son of Bluto Three and Son of Bluto Four, but mostly we use the acronyms. Once Animal House became entrenched in everyone’s mind, the only logical name for the hub was Delta House, the fictional fraternity’s home base.”

Securing the Leases

The majority of the acreage that makes up the Delta House development and some of its secondary prospects was initially gained through a participation agreement with Houston Energy, an exploration company that had purchased 26 deepwater blocks from ConocoPhillips.

“We already held some nearby acreage and had an interest in the ConocoPhillips blocks, but we were beaten to the altar by Houston Energy,” says Mike Altobelli, LLOG vice president, land. Soon after, we reached a deal with Houston Energy that gave us 32.5 percent in those leases.”

The problem was, the leases were about to expire. The longest of them had just three years remaining.

“We had to act fast,” Altobelli says. “We assembled our group of owners, which included LLOG and the companies in the Houston Energy partnership. Together we approached the Bureau of Safety and Environmental Enforcement (BSEE) and were successful in obtaining a five-block unit for one prospect and a separate two-block unit for a second prospect to advance our drilling program.”

The BSEE granted “Suspensions of Operation” to the partnership so drilling could proceed, but at least a few of the regulators had doubts that LLOG could drill the wells in time.

“We were very transparent in our presentations to the BSEE, and since then, we’ve done everything we said we were going to do,” Altobelli says. “It was a pretty dynamic time. I’ve never been involved in a project with that much going on in such a condensed period of time. The lease exploration dates were staring us in the face. We had to get out there and drill wells.”

After the partnership’s first two discoveries came in, the same agency granted “Suspension of Production” permits to allow time to complete the development through initial production from the unit or lease. LLOG and its partners’ commitment to developing the fields was the basis for the granting of the Suspensions of Production.
Banking on the Bit

Visionary financing allows early sanctioning

Two separate groundbreaking deals—signed just days apart—are as much a part of the Delta House story as the field itself. It’s likely that the agreement to fund the host platform is the first of its kind in the oil industry. Much of the credit for the Delta House development goes to ArcLight Capital Partners, majority owner of the host platform, and Blackstone, partners in a LLOG joint venture, which is the largest working interest owner of the subsea wells.

**Funding the FPS**

The seven companies that own the leases do not own 100% of the Delta House floating production system (FPS). Instead, LLOG and its partners—owners of the fields—pay a processing fee to the owners of the FPS. While that is unusual, the arrangement is not unique within the industry. In the case of Delta House, it was a critical step that allowed the whole project to work. The commercial contract, which involved a total of eight companies, is quite complex. The final agreement runs more than 8,700 pages, yet it was completed in only six months.

"Delta House would have been difficult to execute without ArcLight," says Philip LeJeune, LLOG’s chief financial officer. "Even though ArcLight is a private investment firm that focuses on North American energy assets, not many investment teams would have gone the extra mile to make this project work.”

"We could have put up the capital to build it ourselves, but that would have meant a large investment in the midstream side of the business.”

When LLOG opened 2012 with two major discoveries in the Gulf’s hydrocarbon-rich Mississippi Canyon, its project team began evaluating ways to produce the reserves. One option was to pipe the oil and gas from subsea wells onto existing platforms owned by other operators, but the closest potential hosts were 26, 29 and 35 miles away. The distances raised flow assurance questions and other serious issues. Based on the volume of reserves they had found, building a new facility made more sense. The next question was, how best to pay for it?

"We could have put up the capital to build it ourselves," LeJeune explains. "But that would have meant a large investment in the midstream side of the business. The other option was to have a third party build and own the FPS, then pay them fees over time to process the oil and gas we produce. Since we prefer spending our money on exploration, the second option was a better fit.”

An interesting point is that ArcLight does not own any of the reserves, only the FPS and the export pipelines. If needed, ArcLight could sell the FPS, since the design is suitable for most deepwater developments in other parts of the world. That part of the agreement makes the investment more secure, because the FPS effectively serves as collateral.

Negotiations began in April 2012. By May, the companies had the basis of a deal: ArcLight would provide 51 percent of the $860 million needed to build the FPS and export pipelines. A consortium of six exploration companies, including LLOG, would fund the rest.
"We’ve Got Something Here"
There was a turning point in the early meetings when it became clear just how valuable the location was relative to other producers in the area. Even if the volumes from LLOG’s wells proved disappointing, it was likely that future Mississippi Canyon operators would want to use the Delta House FPS to process their oil and gas.

“When they studied the maps, our partners could see that infrastructure in this area was going to be valuable,” LeJeune says. “Even before the project had been completed, one partner committed to route production from one of its recent discoveries to the FPS. Overall, the Delta House reserves have more than doubled since the time ArcLight underwrote the transaction. I’d say this project is a winner for everyone involved.”

Early Sanctioning
One result of ArcLight’s controlling interest in the FPS is that it allowed for early sanctioning of its construction. Other companies typically wait for more wells to be drilled before they approve construction of the production facility. In this case, ArcLight has a controlling interest in Delta House, but

Companies typically drill more wells before they start building the production facilities,” LeJeune explains. “In this case, however, ArcLight accepted some risk of the production on these fields and offset that by the fact that they could attract other fields if ours perform differently than projected. Because of that, we were able to sanction the FPS much sooner. When you compare the timing of this project to others of this scope, I think we’ll come in about two years faster than average.”

Funding the wells
Besides the floating production system, the original Delta House development plan called for at least three deepwater wells, plus the infrastructure to connect them to the FPS. Since then, the plan has grown to include seven wells during the startup period. The estimated cost of the seven wells was $1.2 billion. That’s where Blackstone and HSBC Bank stepped in.

“We began talking to the Blackstone Group in April, 2012, around the time of our second discovery,” LeJeune says. “Our strategic partnership with Blackstone was the largest of its kind. The joint venture with Blackstone will enable LLOG to capture opportunities that we could not otherwise pursue. Within that arrangement, HSBC and three other banks provide the Reserve Base Loan (RBL) through the joint venture called LLOG Bluewater. Although the financial structure for the RBL had been used internationally, it was the first time for a U.S. operator.”

Securing the Drilling Rigs
Based on the development plan, LLOG knew it would need at least two more drilling rigs on long-term contracts. A pair of three-year contracts would be ideal, but day rates for deepwater rigs are in the range of $500,000. When you add supply boats, tugs and other support, the bill comes to about $1 million per day. Blackstone’s participation made it possible for LLOG to secure two deepwater drilling rigs for three years each. It was a critical component of the Delta House development plan.

“If you look at that level of commitment to make a 3-year contract with a drilling rig contractor, it is $1 billion times two,” LeJeune says. “The Blackstone transaction made those rig contracts happen, which meant we could execute our projects and still do additional exploration. Blackstone and ArcLight were the keys, and the agreements all came together within a few days of each other in late November and early December 2012. We didn’t get much sleep around that time.”

For its part in funding the wells, Blackstone and LLOG Bluewater will get approximately 34 percent of the oil and gas (the working interests vary by field). The rest of the production in various percentages goes to the other partners: Red Willow Offshore, LLC, Calypso Exploration, LLC, Deep Gulf Energy, Houston Energy, and the entities managed by Ridgewood Energy (which includes Riverstone designated affiliates). That same group owns 49 percent of the FPS.
Drilling and Completions

Focused on Efficiency and Safety

The drill bit was still turning in the second exploration well when LLOG began ordering subsea trees. Nine of them, at roughly $7 million each. The purchase took more than confidence. The development team was planning far ahead, not only with the trees, but the wellheads, casing and intelligent downhole systems. Everything had to be ordered long before it was needed in the field. It takes a tremendous amount of planning; safety is paramount, but beyond that, planning mistakes can quickly break the bank.

Standards Reduce Risk
LLOG’s drilling team was sure it could use the equipment that was ordered for Delta House, mainly because the company has standardized its wells. Most LLOG deepwater developments, for example, use the same horizontal trees. Any trees that are not needed for Delta House can be used in other LLOG fields. Standardization adds flexibility, and it also makes it easier for suppliers to respond to urgent requests.

“Any benefit we may give up in terms of a perfect fit for one application, we gain back in terms of responsiveness from our suppliers and the ability to move a project forward,” says Joe Leimkuhler, drilling vice president. “With a horizontal tree, I can get on a well with any riser and BOP stack combination of any deepwater rig in the Gulf of Mexico.”

There are tradeoffs, of course. Horizontal trees are better for major well interventions because you can gain full access to the wellbore without pulling the tree, but if all you need is lighter diagnostic work, a vertical tree has some advantages. LLOG’s subsea manifolds are also standardized. Instead of designing a new manifold for each field, LLOG uses a standard manifold that’s good for four wells.
If the development calls for more than four wells, a second manifold is bolted to the first. Everything is linkable.

The Organizational Model
LLOG has also built an organizational model for well engineering and operations. “For the initial drilling at Delta House we utilized a single experienced engineer per rig,” says Leimkuhler. Senior Deepwater Drilling Engineers Steve Stegeman and Bob McMann filled that role and did an excellent job.”

While the arrangement works for short periods of time, LLOG prefers the dual engineer model for sustained operations with multiyear rig contracts. The goal for each rig is to have one engineer planning the next well while the other engineer oversees the current one.

The lead engineer’s average level of experience is 20 to 30 years. With that level of seasoned talent on the rig, the lead engineer doubles as the operational superintendent. Under LLOG’s system, the engineer who plans the well is typically the one who drills the well.

“On the offshore operations side we have an excellent group of core foremen with substantial deepwater experience,” Leimkuhler says. “The lead engineer is the operational interface with the foreman offshore. It’s a tight package. I don’t have to worry about the handoff interfaces. I don’t have one engineer planning a well and another drilling it in conjunction with a field superintendent. Larger companies have a lot of interfaces that we don’t deal with here. Decisions can be made quickly because all of the decision makers are involved right from the start.”

Safety and Environmental Management
LLOG, like every other producer on the Outer Continental Shelf, operates under a safety and environmental management system (SEMS) as required by U.S. law. LLOG Health, Safety and Environmental (HSE) professionals assist with and oversee the plan. Any changes must be approved by LLOG HSE and LLOG Drilling.

For emergency support, LLOG is also a member of the Helix Well Containment Group (HWCG), a nonprofit consortium of more than 60 mid-sized deepwater operators and most of the larger service companies. Depending on the nature of the spill event, HWCG can deploy its equipment and a full complement of well containment specialists within 48 hours. That response organization includes the technical and operational support of the HWCG member operators. LLOG’s technical staff is part of the network of HWCG experts on call, 24 hours a day. People and vessels are deployed in the emergency drills. In May 2014, for example, LLOG alone sent nine staff members to a command center in Houston for an exercise in which Freeport McMoRan was the responsible party. The group included LLOG’s Chief Well Engineer, Darrell Herrington and several lead engineers.

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“We are trained to serve in various roles in all the well containment subgroups, including source control chief,” Leimkuhler says. “We train as a group of companies once a year. Every time we have an emergency drill, the messages go out to all the other member companies. Within three days, we can have the whole source control organization filled out by experienced people from our own organization as well as other HWCG member companies.”

Joe Leimkuhler, LLOG’s drilling vice president.

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Joe Leimkuhler, LLOG’s drilling vice president.
Drilling the Wells

By the end of 2014, six of the proposed 15 Delta House wells had been drilled. To handle the workload on Delta House and other projects, a good portion of LLOG’s staff are professional engineers. As a result, all of the company’s professional engineering work led by Chief Well Engineer Darryl Herrington is done in house, including certification.

“We have a sizeable drilling organization,” Leimkuhler notes. “Many companies our size rely more on contract staff they bring in for specific projects, but we chose to gear up for the long haul. We’ve built a drilling and completions group, with engineering and operations staff sufficient to run three to four houses, including certification.”

Of the first six Delta House wells, two wells were drilled by the Ensco 8502 in 2012-2013, two were drilled by the Noble Amos Banner in 2011-2012, and the Ensco 8503 drilled the 6th Delta House well in late 2014, followed by the initial two subsea completions for the field. The Sevan Louisiana is scheduled to drill wells 7, 8 and 9 in 2015. The Sevan Louisiana, which uses an exceptionally stable cylindrical hull design, is a DP rig that has also proven to be fuel efficient, with enough storage capacity that it can be used as a temporary liquid mud depot if needed. A second vessel, Seadrill’s West Neptune drill ship was delivered to the field in late 2014. The newly built West Neptune is designed for water depths up to 12,000 feet and drilling depths to 37,000 feet. The West Neptune is outfitted with dual BOP stacks to enable efficient completion of the remaining wells in the field. Both the Sevan Louisiana and the West Neptune are under three-year contracts with LLOG.

Each Well is Unique

“Even though our wells are in a similar geologic setting, each of them is unique,” says Leimkuhler. “At the Marmalard field, for example, our delineation well was more than three miles from the exploration well. When you’re that far away, you can’t assume that pore pressures are the same, even if the rock is in the same trend.” Experienced and capable engineers such as Steve Stegeman and Jason Brink work closely with the LLOG Petrophysical engineers and LLOG foreman on the rig. Together, they optimize operations and allow LLOG to determine quickly how best to develop the Delta House fields.

Stegeman, Brink and the rest of the drilling team were confident enough to make sure that even the first two exploration wells could be completed as producers. “Every well we’ve drilled to date was designed to be a producer,” Brink says. “We don’t drill expendable wells. We might in the future, but not yet.”

Smart Completion Technology

The wells feeding into the Delta House FPS will have a variety of completions. In some cases, a typical wellbore intercepts several pay zones that are anywhere from 50 to 100 feet thick. The gross interval between the upper hydrocarbon-bearing sand to the lower one might be as much as 600 feet.

“Reservoirs with shale breaks between pay zones will have multiple frac packs to maximize production, and smart well technology to manage it,” says Senior Deepwater Completion Engineer Barney Parnemos. “We generate a single wing to make sure we get past any near-wellbore damage from the drilling fluids, then open things up and pump our proppant. We use screens to keep that proppant from entering the wellbore during production. We could probably get by with gravel-packs, but frac-packs are better producers.”

Erik Hoffpauir, a completion engineer also working Delta House, notes that all of the wells are drilled directionally to reach individual sands, but none of the wells are horizontal. The formations themselves are very plastic, so proper placement of the proppant is important to enhance permeability around the wellbore.

In for the Long Run

“Delta House is just one of several hub-class prospects in our portfolio,” says Tim Lindsey, senior vice president for operations. “We’re going to drill them, but to operate safely, you have to be realistic about how many rigs you can supervise and how many wells you can plan. We’re challenged enough to develop what we’ve found and explore what’s on the horizon. Generating the most net present value is a unique riddle sometimes, but that is what we do best. As folks here in Louisiana like to say, ‘Clean the fish you’ve caught and have the bait to catch more.’”

Even though Delta House has been a fast-paced development, its safety record has been very good across the board.

“We have outstanding, experienced supervisors on the rigs, and they are really our first line of defense for safety and safe drilling practices,” says Lindsey. “As a company, we don’t often have time to celebrate all the significant things that happen. The wells we drill, delineation of the field, construction of the hull and topsides, integration, transport, mooring and commissioning—each of those accomplishments are tremendous things. Sometimes things don’t go as well as we had planned, but how we react to those challenges is what makes LLOG the company that it is.”
Geology of Mississippi Canyon

Reading the reservoirs

From the geologist’s viewpoint, the already difficult search for oil in the Gulf of Mexico is further complicated by a thick layer of salt that formed when the region was a shallow sea. Over millions of years, layer after layer of sediment deposited above the salt caused it to act in strange ways, forming huge domes and ledges that oozed toward the surface. In geologic time the salt structures grew, shoving older sedimentary layers aside. Fresh sediment flowed around them. Throughout much of the Gulf of Mexico and inland for hundreds of miles, these massive salt formations also trapped hydrocarbons that would otherwise have leached to the surface long ago.

The roughly 400-square mile region known as the Mississippi Canyon is a dominant feature on subsea maps. Its central trenches and cliffs began taking their modern shapes some 20 million years ago, as snaking regional rivers carved through the land and dumped their organic-rich sediment into the sea. Today, the Mississippi Canyon is home to some of the largest deepwater developments in the Gulf of Mexico.

In 1979, Shell’s Cognac project on Mississippi Canyon 194 became the first deepwater development in the area. Since then, most of the major oil companies have explored it with varying success.

"Some of the majors looked at the area where we are today and thought that the reservoirs weren’t large enough to be commercial," says LLOG’s John Doughtie, vice president exploration, Houston. "That was several years ago. Using the latest seismic technology, we were able to image the reservoirs with a clarity that wasn’t possible then. It has opened new opportunities for us. As we drill more wells in the Mississippi Canyon, we’re beginning to understand the basins much better."

Home Team Wins
"We have an extraordinary number of people involved on the subsurface side," says Eric Zimmermann, LLOG vice president geology. "Our partners at Houston Energy were on the front end of exploration as well. We have..."
some really good partners who know what they’re looking for. They see things the way we do, but they’ve also added to the project. They have certainly kept us on track.”

By any standard, Delta House is a world-class prospect. So is the geoscience team that found it. “Between our capabilities and those of our partners, no part of the puzzle is being outsourced.” Zimmermann says. “Individuals within our organization are doing all of the specialized geoscience work. Carlos Guzman, an exploration geophysicist here in Covington, helped to identify key target areas. John Hollins, our seismic reprocessing coordinator in Houston, works on small-scale velocities and details on the geophysics side. Malloy French, Jay Cole and Stan Hewitt are all well respected in their fields in the industry. It is most unusual to have such talent in a private company our size.”

Proving the Model
No matter how good the models look, explorers never know for sure if they’ve got oil until they find it with the bit. In February 2012, LLOG’s Mississippi Canyon 431 Number 2—the one dubbed “Son of Bluto 2”— came in strong. A second high-profile well, Mississippi Canyon 300 Number 1, dubbed Marmalard, became the discovery well on the second of three Delta House fields when it reached total depth some four months later. So far, the Delta House field appears to have even more potential than the geoscience team first thought.

“The good fields tend to get better with time, and we’re still drilling wells and learning more about the resource,” Zimmermann adds. “We’re still peeling back layers of the onion.”
LLOG is known for efficiency, in part because it looks for ways to standardize even its offshore platforms. The Delta House FPS is a larger version of Exmar’s very successful Opti-Ex® platform used in the Who Dat field. Exmar’s design, customized to LLOG specifications, is the first in what LLOG sees as a series of floating production systems, all with the same basic Delta House plan. Early work has already begun on its twin.

“The Delta House program is the bigger story,” says Rick Fowler, LLOG vice president deepwater projects. “In keeping with the effort to standardize our facilities, we’ve designed a semi-submersible platform that we can deploy in a wide range of conditions.”
The Concept Evolved
Delta House is a four-column semi-submersible floating production system based on Exmar’s Opti-Ex® design. It is similar to LLOG’s successful Who Dat platform, but 40 percent larger. As the name implies, the hull is optimized to increase the amount of payload it can carry relative to the weight of the steel in its hull.

A prominent feature of the Opti-11,000® is that it reduces the cost and weight of the hull without sacrificing strength. Look closely and you’ll see that the columns are square only on the outer corners, where structural loads are the greatest. To the inside, the faces of the columns are diagonal. That saves steel, which means the structure itself is lighter and more buoyant than conventional four-column hulls. Another weight saving feature is the way the risers attach to the FPS.

“The way the hull is designed, we swap off risers for ballast,” says Craig Mullett, project manager for the hull and topsides. “If we tension the risers at the top of the hull, we sacrifice weight capacity. By fastening our risers to the bottom of the hull instead, we save the weight.”

Delta House is larger than Who Dat, and it can support more topside weight. The payload went from 5,000 to 9,300 metric tons. While the Delta House hull is 55 percent heavier than Who Dat’s hull, the payload nearly doubled. The hull-to-payload weight ratio for the Delta House FPS is nearly one-to-one.

The Opti-11,000® is suitable for water depths from 1,500 to 10,000 feet. The hull has a payload capacity of 11,000 tons, and it is relatively easy to build. To minimize the effects of ocean heave in shallower water, the FPS can be fitted with flexible risers. Even the shape of the hull makes it more stable than older designs.

“Heave—the tendency for a vessel to rise or fall in the water—is the enemy of four-column semi-submersibles,” Mullett explains. “But one feature of our design effectively resists much of the vertical inertia caused by heavy seas. We call it a ‘ring pontoon.’ Its outer edge extends beyond the columns, like a wide shelf sticking out below the water line. That extra drag in the water greatly dampens any vertical movement.”

Selecting the Fabrication Yards
“We began looking at construction yards for the hull and topsides as soon as we acquired the leases, long before our first Delta House discovery,” says Bruce Cooley, vice president facilities. “We have a potential development scenario in mind for every deepwater lease we drill. For the Delta House FPS, we settled on Exmar’s basic design in November 2011 and began looking at preliminary layouts.”

By selecting the construction yards early—Hyundai Heavy Industries for the hull and Kiewit Offshore for the topsides and integration—LLOG could involve the yards early in the design process. It also meant that the capabilities of each yard could be incorporated from the start. The Kiewit yard at Ingleside, for example, has a maximum lift capacity of 13,000 tons, so that became the upper weight limit for the Delta House topsides. Since the payload of the Opti-11,000® hull is 11,000 tons, there is excess capacity for future expansion.

Keeping to the Schedule
“There are always plenty of challenges on a project this size,” Cooley says. “One of the biggest was that other jobs in front of us in the Hyundai yard ran late. That meant we...
The Delta House single deck design allowed more flexibility in the delivery and installation of individual components.
couldn’t get into dry dock on schedule. Toward the end, it rushed the construction of our hull. Hyundai did a great job of getting it together, but I’m sure it caused them a lot of headaches.”

In keeping with LLOG’s policy of developing solid, long-term relationships with its suppliers, Dockwise was contracted to deliver the hull from South Korea to Texas. “Dockwise does all of our transportation,” Cooley says. “We made sure that our hull would fit on any of the six T-class vessels that Dockwise owns. We didn’t want something so big that only one vessel in the world could move it.”
The Opti-11,000® hull finally left the Hyundai yard aboard the Dockwise Treasure heavy transport vessel on March 25, 2014 for the two-month trip to Kiewit’s yard at Ingleside, Texas. Once there, high winds forced crews to wait another two weeks until the hull could be safely offloaded. Even with the weather delay, the Delta House team maintained the overall project schedule.

“We pre-installed our pipelines,” Cooley says. “We pre-set the mooring system. The idea was always to lay the pipe ahead of time, have the lay vessels go away, moor the FPS, then have the vessels return to tie it in. That flexibility allowed us to close the gap in the schedule.”

Tweaking the Topside
Delta House was designed to be extremely flexible in the variety of crude oil it could process. The acceptable API gravity range is 28 to 38, which includes the majority of crudes in the Gulf of Mexico. Even so, the project team had to make last-minute changes to accommodate some unusual properties of the gas.

“We found that the crude had a lot of light ends, and the gas had a lot of heavy ends,” Cooley explains. “Normally you wouldn’t have those two at the same time. That meant that we would be producing more propane and butane than we anticipated.”

The fix was to add a condensate stabilization unit to the processing equipment. Fortunately, the Delta House production deck had plenty of extra room and weight capacity. Adding the stabilization unit allowed LLOG to inject the liquids into the sales gas pipeline, which transformed them and increased the richness of the gas.

The Advantage of a Single Main Deck
Most FPS designs use three decks, which means that during construction, everything that goes down below must be installed before the upper decks can be set on top. Using a single main deck design instead gave the LLOG team more freedom to make last-minute adjustments to the topsides construction without throwing the project off schedule. Later, the ability to mate the topsides to the hull in one lift at Kiewit’s dock was also much safer and less expensive than trying to do the same job with heavy lift vessels offshore.

Massive slings were attached to lift the 9,580 metric-ton Delta House topsides onto the hull.

“Having a single main deck made the FPS much easier to build,” Cooley explains. “With all of the production equipment on one elevation, we could build equipment off site, then integrate it onto the top deck. If something didn’t come in on time, we had the flexibility to add it later. We weren’t waiting on one piece of equipment so we could sandwich another deck on top of it.”

That flexible single-deck design enhanced safety for the construction crews and also shortened the project’s cycle time. “We were still designing some components while others were being built,” Cooley says. “Detail drawings were arriving just in time.”

From sanction of the project to installation took just 22 months, a near record for the industry. To help maintain the aggressive topsides construction schedule, Project Manager Craig Mullett spent most of his time at the Kiewit yard, overseeing work and answering questions on the spot. “That’s one of the benefits of a small project team,” he says. “We don’t have to go through layers of management to make decisions. We know what our boundaries are, so if we do have a question, we can run it up the ladder. Our management is always accessible, even the guys in the corner offices.”

Much of the topside equipment was skid mounted, which meant it could be built offsite.
LLOG’s emphasis on safety paid off with a 12-month total recordable incident rate (TIRR) of just 0.34, about twice as good as the industry average of 0.66.

Topsides Integration
In December, 2012, as ink was still drying on the ArcLight and Blackstone contracts to fund the $2 billion project, Kiewit crews began building the Delta House deck. Workers at Hyundai’s yard in South Korea began cutting steel for the hull on March 4, 2013. The hull was offloaded at the Kiewit yard on May 29, 2014, and two weeks later, the integrated truss deck and topsides facility was added to the hull. At 9,580 metric tons it was the heaviest single lift the Kiewit yard had ever done. The operation was flawless. From the time the hull was positioned until the load was released took less than five hours.
Ceremony at Ingleside

On July 9th, 2014, hundreds of people gathered at Kiewit’s windy 500-acre fabrication yard at Ingleside, Texas, about 15 miles from the city of Corpus Christi. Inside a huge white air-conditioned tent, crews taking a break from their jobs mingled with reporters, photographers, joint-venture partners, investment bankers and project executives. Outside, the nearly completed Delta House FPS towered over the yard, dwarfing nearly everything in sight. From its 2-acre footprint to the tip of its flare, the 18,600-ton vessel stood 296 feet tall.

While integration and commissioning work continued high above on the topsides deck, speakers at the christening ceremony expressed their appreciation for the work that was done by the 12,000 people worldwide who had a hand in the Delta House project. At the appointed time, Sharon Speakes, a longtime employee of LLOG, officially named the vessel “Delta House” and released a champagne bottle that burst against the hull. Even though the FPS wouldn’t leave the yard for another two months, every visitor that day could see that the Delta House FPS was well on its way.

Delta House is powered by three 4.8 Megawatt Solar Taurus 60 gas turbine generators. The electricity they deliver runs all the rest of the equipment and utilities, which increases reliability and reduces noise on the platform.

The entire topsides assembly consists of a single deck that was fitted to the hull in one lift.
Completing the package

The project prepares for first oil

By August 2014, the project team had completed nearly all of the topsides engineering work, but the work that remained was still daunting. The FPS was still in Kiewit’s yard as technicians checked the critical systems required to earn the U.S. Coast Guard’s approval to take the new vessel out to sea for the first time. As the FPS was nearing completion, a small fleet of ships and barges were busy in the field, installing the rest of the field’s infrastructure.

**Subsea Systems**

Three separate subsea systems, each with the capacity to support eight wells, feed all of their produced fluids to the Delta House FPS. Equipment on the seabed is linked by a fiber-optic communication system, and each well has its own multiphase meter.

“Both of those are unique for us,” says Bruce Cooley, who managed the subsea installations. “Using fiber-optics instead of copper wire greatly improves the equipment response time. Where the old system might take 30 seconds to transmit some data, the fiber-optic system is nearly instantaneous.”

The use of multiphase meters gives reservoir engineers the chance to monitor what each well is producing. As fluids come from the well, engineers at LLOG offices can see how much of it is water, gas and oil. In addition, downhole pressure and temperature sensors in each well update their readings every few seconds.

One feature of the Delta House subsea system is that all of the production lines are looped. Looped lines give operators the ability, in the case of a damaged line, to redirect the flow into another line.

“Looped lines also allow us to clean the loop train,” Cooley notes. “We can launch pigs from the topside and round-trip them through our flowlines. If we ever have to shut in for a hurricane, or any maintenance operation that requires pigging, we can do both lines simultaneously.”

Another advantage of looped flowlines is that the flow from stronger wells doesn’t have to be commingled with the flow from weaker wells.

“If you want to maximize recovery and have all your wells on a similar depletion plan, looped lines give you more flexibility,” Cooley says. “You can maximize the flow from lower pressure wells so they don’t have to compete with higher pressure wells.”

Likewise, it’s easier to dedicate one of the lines to gas wells and the other flowline to oil wells, if desired.

**Mooring and Integration**

Twelve mooring lines—each more than 1.5 miles long—keep the Delta House FPS on station. They’re anchored to a dozen...
matching 16-foot diameter suction piles that weigh 150 tons each and reach some 80 feet into the seabed. LLOG’s Mark Farrow, offshore construction manager, directed the installation of the piles and later, the mooring operation itself.

“The mooring lines are a combination of polyester rope which is about 10 inches in diameter and steel chains with links that weigh nearly 500 pounds each,” Farrow explains. “Lengths of chain attached to the upper ends of the polyester ropes allow each line to be tensioned independently.”

Given the extreme weight of mooring lines, most companies use heavy lift vessels to install them. The Delta House team was able to economize by enlisting one of the anchor handling vessels already on contract with LLOG, and modifying it slightly to do the job.

By October 2014, the FPS was successfully moored in Mississippi Canyon 254, some 130 miles southeast of New Orleans in 4,500 feet of water. Once it was ballasted down to working depth, the underside of the main deck was 72 feet above the water line, with 98 feet of the hull below the waves.
Operations

Safety and operational integrity are key

About two dozen people live aboard the Delta House FPS for two weeks at a time between crew changes, but there is space for twice that many if extra workers are needed for special jobs. A supply boat trip to the Fourchon shore base near Grand Isle, Louisiana takes about six hours or a helicopter ride to the Galliano base takes about an hour.

The Delta House host platform receives all of the raw production from the wells and subsea gathering system that serves three separate fields. Onboard processing equipment uses mainly gravity and pressure reduction to separate the fluid’s various components and to bring the natural gas and oil up to the specifications of the export pipelines.

Marketing
Delta House is designed to process a wide range of gravities and gas-oil ratios. Likewise, the FPS can deliver its oil and gas at a range of export pressures to suit any pipeline in the Gulf of Mexico.
Oil from Delta House flows through some 35 miles of newly-constructed 12-inch pipe that connects to the Shell-operated Odyssey oil pipeline. Gas from Delta House is delivered through 31 miles of new 16-inch line that links the FPS to the BP Pipelines-operated Destin Pipeline Company’s 24 inch gas pipeline.

“We use a number of factors when selecting our export pipelines, including the capital cost, capacity, netback price, and reliability of each option,” says Jack Boebe, director of marketing. “In the case of Delta House, we were fortunate to have a number of good options. Shell and BP have been great to work with on this project.”

Storm Safe
The Gulf of Mexico is famous for its hurricanes, which keep offshore operators watching the skies from early June to late November. Even the threat of a big storm can shut down platforms days before the main event.

“If a hurricane is imminent, we follow a detailed evacuation plan,” says Rick Bullock, production vice president. “The evacuation procedure for Delta House is much simpler and quicker than many similar facilities that require changes in draft or mooring tensions. The FPS is quite robust and is designed to withstand the impact of a thousand-year storm. After the storm passes and the weather is safe, the crew would return and restore production, following another detailed plan.”

Other safety features are built into the Delta House design. The legs of the FPS, for example, are fitted with elevators and stairwells rather than ladders. There are also safety tunnels in the pontoons. Most of the topsides equipment is electric rather than being powered by diesel fuel or natural gas. The result is a working environment that is quieter, cleaner and more efficient than most offshore platforms, and it is more reliable.

Drilling Continues
In June 2014, the round-hull Sevan Louisiana rig began working in Mississippi Canyon block 79, just north of the first two Delta House wells. The plan was to finish that well, move the Sevan rig to complete a second Delta House well, then send it along to a third site. In early August, however, there were a series of delays in the Delta House drilling program. The Sevan Louisiana did not complete its work on MC 79 until late October. The good news is, the well was a significant new find.

The new well logged more than 70 feet of net hydrocarbons in a Miocene reservoir with a high yield of gas condensate. Part of the delay in moving the Sevan Louisiana was the time it took to drill an appraisal sidetrack, which confirmed the discovery. LLOG, which owns 70 percent of the field, is the operator. Ridgewood Energy managed entities (which includes Riverstone designated affiliates) is the non-operating partner. Delta House will likely be the host platform.

The West Neptune Moves In
One of LLOG’s three deepwater drilling rigs is the newly built Seadrill West Neptune, which was delivered to the Gulf of Mexico in December 2014. The West Neptune is LLOG’s first dual-BOP deepwater drilling rig. U.S. law requires that a blowout preventer must be disassembled and tested after each use, a process that takes about two weeks. Having two BOPs on board means that one can be tested and recertified while the other one is in use. That saves at least 12 days off the time it takes to complete each new well.
Looking Ahead

In it for the long run

To our knowledge, Delta House and Who Dat are the only two privately-owned deepwater floating production systems in the world. They won't be the last.

“We’ve been fortunate to align ourselves with some very sound partners,” says LLOG’s Chief Executive Officer, Scott Gutterman. “As a private independent, our biggest challenge historically has been securing sufficient capital to underwrite our programs. Especially as we continue to grow our deepwater business and are more frequently confronted with developments that require investment beyond our available conventional resources. In the case of Delta House, ArcLight and Blackstone have been extraordinarily strategic partners. By providing access to additional external sources of capital to expedite this development, they provide an ability to harvest the value we created without diminishing our focus on continued growth through our exploration program.”

A Bright Future for Delta House

The FPS itself is designed for 25 years of continuous production. While the facility is nominally built to process 80,000 barrels of oil per day (bopd), 200 million standard cubic feet of gas (mmscfd) and 40,000 barrels of water per day (bwpd), the peak capacities are at least 20 percent more. By the end of 2015, we expect to have seven Delta House wells on production. The development plans for the known fields include 14 wells, as Rick Fowler, LLOG vice president deepwater projects, explains.

“Our plan is to continue our development and exploration activity in the area to get the facility full and keep it full as long as possible.”

Fowler says. “If we do reach 100,000 barrels per day, we’ll look at debottlenecking the facility. The absolute production limit is the export pipeline, which can handle about 117,000 barrels per day. How close we get to that depends on our drilling success in the known fields and nearby prospects.”

Is there room to expand the Delta House FPS? “Yes,” says Delta House Project Manager Craig Mullett. “And there is even more weight capacity than deck space. We have 1,000 tons extra capacity, but it would be difficult to get 1,000 tons of equipment out there without building extensions on the deck.”

LLOG has a healthy prospect inventory in and around the Delta House development. In October 2014, LLOG and Ridgewood Energy announced test results from an exploration well at the Mississippi Canyon 79 “Otis” prospect. The well encountered more than 70 feet of net hydrocarbons. A subsequent appraisal sidetrack confirmed the discovery. LLOG, which owns 70 percent of the field (30% is owned by Ridgewood Energy managed entities which includes Riverstone designated affiliates), has been evaluating development options and regional hosts, including the Delta House FPS.

A number of other projects are scheduled for testing, but even with the three deepwater drilling rigs LLOG has on long-term contracts, there aren’t enough rig days available to drill its entire inventory. For now, the contract rigs will focus on the Delta House development. As rigs become available, they will be redirected toward exploration. If all goes well, the Delta House FPS will eventually have a twin, and another after that. The FPS is optimized to be as flexible as possible in terms of where it can deploy and the types of production it can handle. Changes will likely be in the nature of equipment upgrades as new technology is available.

“The second FPS we build in the Delta House program will probably have minor differences from the first, but no substantial changes,” Mullett says. “We don’t need to touch our production module, where we have all our separation equipment. The third one, if we build it, will be extremely close to the second one. From here on, it’s all about fine tuning what we’ve got.”
Exmar's Innovative FPS: Optimization and Efficiency by Design

Exmar Offshore Company (EOC) provides engineering services related to the marine industry with a special emphasis on the oil and gas segment. EOC’s expertise encompasses ships and offshore units such as floating production systems, drilling rigs, accommodation units, floating production, storage and offloading units and floating storage units. EOC is a full life cycle maritime business with capabilities including concept development, basic and detailed design and engineering, construction, project management, start-up, commissioning and operations.

EOC's parent company is Exmar NV (Exmar of Antwerp, Belgium), a diversified and independent shipping and offshore group. Exmar NV is a recognized leader in designing, owning and operating vessels that transport liquefied gases (LNG, LPG, ammonia) and floating LNG facilities (LNG, LPG, ammonia) and floating LNG (Exmar) of Antwerp, Belgium, a diversification in the offshore segment is to own and operate assets with the support of its engineering division, EOC. Within the Exmar Group, EOC develops new concepts and design improvements to existing marine technology. This mandate for innovation led EOC to introduce a new design for a semisubmersible floating production system (FPS). In 2004, EOC created a unique hull design, named the OPTI®, optimized for minimal movement and efficient use of material. Market conditions at that time projected the demand for floating production facilities in the Gulf of Mexico and globally would be considerable. Exmar management was confident the OPTI® hull design had unique characteristics that would give it a market advantage in performance, constructability and operational flexibility. With a standard hull design and flexible topsides configuration for “typical” Gulf of Mexico production, detailed design and construction would be quicker, production of first oil would occur sooner, and returns would be improved. Based on this assessment, Exmar made the decision to speculatively order an FPS named OPTI-EX® utilizing the OPTI® hull and unique topsides design concept. LLOG Exploration acquired the initial OPTI® FPS and made it central to the Who Dat project. The success of the project validated the Exmar approach. In 2011, the OPTI-EX® Who Dat FPS sailed to location less than 12 months after signing an agreement with LLOG.

While Who Dat achieved first production as planned and is efficiently producing oil today, the real proof of success is shown by LLOG’s selection of the OPTI® hull design approach for their second deep water development, Delta House. EOC is proud to partner with LLOG and help them continue to achieve their business objectives.

Innovation Applied – Unique Characteristics of the OPTI®

The OPTI® innovation challenge was to design a production semisubmersible hull with better motions and an efficient structural design to achieve optimal hull-to-topsides weight ratio. The hull design needed to be flexible for variable operational requirements and fabricated as efficiently as possible. The OPTI® addressed these design drivers and is an economically attractive solution. The OPTI® is immediately recognizable from its proprietary column shape and ring-pontoon design. The combination of the unique pontoon and column shape delivers better performance in most offshore environments worldwide. Because the design was conceived to be scalable, the benefits of the design are preserved with different topsides load requirements. The OPTI-11,000® achieved a hull steel weight-to-topsides payload ratio of one-to-one.

In addition to the hull design, EOC designed a proprietary riser porch / riser adapter connection that mates with any riser more quickly than conventional connectors. This design has unique, repeatable and proven efficiencies in installation that were employed in both the Who Dat and Delta House developments.

OPTI-11,000® for Delta House – What is New?

As with any design, the second implementation incorporated changes and improvements. Some were genuine applications of “lessons learned” while others were specific to LLOG and the field, however, all the unique performance benefits of the design were preserved with an improvement in operability. For Delta House, reusing the OPTI® hull design allowed for an optimized schedule and the flexible single-level deck layout simplified the design for the topsides processing equipment. Combined with an accelerated execution plan implemented by LLOG, the ambitious project schedule was achieved.

The Delta House overall production capacity needed to be considerably greater than Who Dat, with a peak daily rate of up to 100,000 barrels of oil and 240 million cubic feet of gas. EOC had already been considering the challenging to create more deck area and deal with the subsequent additional weight. One of the key aspects of the OPTI® series is to make the semisubmersible hull design as independent of the process equipment as possible. The proprietary ring-pontoon provides stability in most sea conditions and an open deck space entirely accessible for crane lifts. Version two of the OPTI® series, for Delta House, is designed for 4,679 square meters (50,357 square feet) of
Deck space and can accommodate up to 9,300 metric tons of production facility modules and equipment. Essentially, the hull for Delta House is 50% larger and oil production capacity nearly doubles that of Who Dat. The table below shows the key changes from the OPTI-EX® to the larger OPTI-11,000® for the Delta House development.

The hull and topsides integration required close coordination with Audubon Engineering, the topside design company for Delta House. EOC and Audubon held regular meetings to address the total weight of the topsides and center of gravity calculations. These two design parameters were critical for the EOC design team to ensure the hull and topsides deck truss structure would meet the required operating service parameters. Unlike traditional ship hulls and spar designs which have multiple decks, complicated pipin- ing arrangements and access interactions, the deck on an OPTI® hull design is primarily based on a flat, single-level surface. The positioning of the process equipment is important for the deck’s center of gravity calculations to ensure the heavy-lift crane can optimize its lifting capability during deck and hull mating operations. The Delta House and Who Dat topsides were built onshore at Kiewit Offshore Services and integrated quayside with the hull in a sin-

gle lift, completed within hours in both cases. This approach allows faster construction, integration, and commis-
sioning time.

The Delta House design benefited from the experience of early direct op-
erator involvement and the experience of the OPTI-EX® on Who Dat. EOC was pleased there were no major unfore-
sen changes, but acknowledges each design iteration will enhance the next. Some of the benefits in the second de-
sign in the series included:

- Column stairs and elevators for easier pontoon access
- Access tunnels between pontoon pump rooms and columns for improved operations and inspections
- Improvement in the proprietary riser attachment design
- Application of a new riser pull-in method for easier installation

**OPTI® Vision – What is Next?**

The market is receptive to an opportunity to get to first oil faster, and EOC is committed to continue to improve the offshore O&G business through innovation as demonstrated by the new OPTI® FPS design. LLOG achieved success with Who Dat and is now heading to another successful milestone with Delta House. With this validation, EOC continues to refine its vision for the OPTI® de-
sign beyond versions 1 and 2.

The hull and flexible topsides ar-

rangement can allow redeployment of an OPTI® design to a new field. A smaller re-

serve base may have an expect-
ed life of 5 to 10 years, which in deeper water may not be commercially viable. However, with a flexible, standard con-

figuration and shorter delivery time, EOC’s proprietary design may help make smaller fields more economical.

The standard OPTI® hull design’s flat deck for topsides process equipment can be more easily reconfigured for different compositions of oil and gas. This opens a new business approach for field developments and smaller fields in particular. EOC’s core business mod-

e is to own and operate marine assets. Therefore it could own the FPS and make it available to an operator for field development and production on agree-
able commercial terms. It is a business model that may appeal to an operator preferring to focus its capital into ex-

panding reserves rather than into fixed assets. For operators who prefer to own and operate their assets, EOC is fully committed to provide the OPTI® hull or complete FPS on a turnkey basis.

EOC’s FPS design is a hull sized for gas production. To provide more deck space and to handle additional weight, we are considering a six-column de-
sign in addition to our standard four. The additional space on deck will allow for more flexibility in equipment selec-
tion, layout and overall mission (drilling and production).

Thinking beyond the traditional FPS market, EOC is working on extending the application of the OPTI® hull de-
sign to support a drilling rig configu-
ration. The deck space could also be ideal for accommodation and work-

over services. LNG processing, up-

grading of heavy crude, or remote compression of gas are also well with-
in the capabilities of the unit. Having two OPTI®-based facilities in deepwa-
ter Gulf of Mexico installed in the past 5 years allows us to take a proven de-
sign to new applications with a high degree of confidence.

LLOG and Exmar Offshore have part-
ned on two highly creative and excit-
ing projects. The success of Who Dat and Delta House is thanks to the hard work and dedication of many people and their respective companies. EOC is pleased to have the OPTI-11,000® be an essential part of the Delta House project.

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**HULL**

**PRODUCTION CAPACITIES**

- **HULL WEIGHT**
  - Displacement: 3,900,000 metric tons
  - Topsides Nominal: 11,000 metric tons

- **COLUMNS ACCESS**
  - Ladders
  - Elevators and Stairs Tunnels Connect All 4 Pump Rooms

- **DECK SIZE**
  - 60.0 m x 60.0 m
  - 68.4 m x 68.4 m

- **TOPSIDE**
  - Oil Production (Peak): 60,000 bopd
  - Total Fluids (Peak): 120,000 bpd
  - Gas Production (Peak): 150 MMscfd

- **HULL CONFIGURATION**
  - Deck Size: 60.0 m x 60.0 m
  - Top of Column ABL: 42 m
  - Draft: 26.0 m
  - Column Access: Ladders

- **PONTOON ACCESS**
  - No Tunnel

- **GENERAL**
  - Water Depth Independent: Yes
  - Suitable for SCR / Flexible and Hybrid Risers: Yes
  - Prime Mover Power: Gas Engine
  - Flaring: Vertical Tower/Inclined Boom

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**OPTI-EX®**

**OPTI-11,000®**

- **Flaring Vertical Tower Inclined Boom**
- **Total Fluids (Peak): 75,000 bpd**
- **Gas Production (Peak): 150 MMscfd**
- **Oil Production (Peak): 60,000 bopd @ 24° API Gravity**
- **Surface. The positioning of the process equipment is important for the deck’s center of gravity calculations to ensure the heavy-lift crane can optimize its lifting capability during deck and hull mating operations. **

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Efficient Sources of Capital

The success of any major project in energy depends on the smooth interplay of many processes and systems. Ranging from steel and pumps to computers and engineering talent, these systems cover a wide spectrum. One system ties them all together, money. Good project management includes having the capital available when required. ArcLight Capital Partners (“ArcLight”) provides that capital to energy-focused companies to help make their projects successful. That is the role they served in the LLOG-operated Delta House Project in the Gulf of Mexico.

The Investment

The Delta House Floating Production System (FPS), located in Mississippi Canyon 254, is designed to accommodate production from a number of nearby fields, including LLOG’s previously announced discoveries in Mississippi Canyon 300 and Mississippi Canyon 431. Oil and gas export lines will connect the FPS to existing downstream pipeline infrastructure. The FPS will have daily processing capacity of 80,000 barrels of oil, 200 million cubic feet of gas, and 40,000 barrels of water with a daily peaking capability of up to 100,000 barrels of oil and 240 million cubic feet of gas. The FPS will have riser facilities to accommodate production from up to nine simultaneously producing fields. The facilities are expected to process and transport production from six initial wells when commercial operations begin in 2015. Total capital required for the project is over $2B.

ArcLight’s Involvement

Affiliates of ArcLight are providing construction financing and will have a majority ownership interest in the entities developed by ArcLight and LLOG to own the FPS and the oil and gas export pipelines. LLOG and its working interest partners (the “anchor producers”) will pay fees to use these “infrastructure” assets. This frees up capital to focus on the exploration and extraction of the hydrocarbons which aligns with their core capabilities. The infrastructure owners will also collect fees from other discoveries developed by the anchor producers and from potential third party tiebacks. The structure developed by ArcLight and LLOG for this transaction carefully allocated risks among the parties and provided a fair return for the capital employed in each aspect of the project. This capital efficiency enabled the anchor producers financial flexibility to bring reserves to market more quickly than a self-funded alternative.

Daniel Revers, ArcLight Managing Partner, commented, “LLOG has a long and successful track record. The deepwater Gulf of Mexico is an attractive and growing domestic production basin, and we are pleased to be partnering with one of the premier operators on this critical piece of infrastructure. We believe that the independent ownership of infrastructure in the deepwater is a win-win model for producers and infrastructure owners that will facilitate the continued development and growth of this prolific supply basin.”

Formed in 2001, ArcLight has demonstrated the ability to aggregate funds to invest broadly and profitably across the entire energy industry. It currently manages over $10 billion in capital commitments across five private equity funds.

THE ARCLIGHT STRATEGY

ArcLight invests across the entire energy industry value chain including coal, oil and gas production, midstream, power generation, gas and electric transmission and distribution as well as related service businesses. ArcLight bases its investments on fundamental asset values and execution of defined growth strategies with a focus on cash flow generating assets and service companies with conservative capital structures. The firm has consistently applied this philosophy and strategy by:

• Employing a diversified, non-directional approach to energy investing;
• Exploiting emerging trends, and identifying hard to find opportunities;
• Investing in hard assets and service companies that produce significant cash flow;
• Optimizing underutilized assets to maximize returns;
• Pursuing private/public arbitrage opportunities;
• Mitigating exposure to commodity risk to create long-term, stable cash flows;
• Partnering with experienced operators and management teams to enhance value post-investment;
• Applying risk management and asset optimization techniques to capture incremental value and protect against downside risks;
• Maximising exit alternatives by pursuing non-traditional means to investment exits, limiting reliance on public markets.

ArcLight believes this approach allows it to identify unique value creation opportunities throughout the energy industry. These investments generate attractive rates of return through a combination of strong current income and long-term capital appreciation while providing significant downside protection and high visibility of investment returns.

ArcLight Capital Partners, LLC

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www.arclightcapital.com
Blackstone Provides Financial Flexibility for LLOG’s Delta House Project

Blackstone Energy Partners is pleased to be part of LLOG’s Delta House Floating Production System (FPS) located in the Mississippi Canyon in the Gulf of Mexico. Blackstone has built a leading private equity investing franchise with an extensive, successful track record of investing in partnership with exceptional management teams seeking to capitalize on their growth opportunities and realize the full potential of their assets. In the past 10 years, Blackstone has committed and invested more than $7.5 billion of equity in 25 energy transactions, throughout the energy value-chain on a global basis. Oil and gas companies represent a significant share of Blackstone’s capital commitments to the energy sector and remain a key focus area for new investments.

Energy is a global, high technology business. Angelo Acconia, the Managing Director of Blackstone Energy Partners who oversees their oil and gas investments, commented on the LLOG partnership, “Critical to the success of an oil and gas company is having the right technical, operational and health, safety and environmental ("HSE") teams in place with a strong track record of success, coupled with the right access to capital and ability to effectuate opportunistic acquisitions. LLOG is a best in class organization on the technical, operational and HSE front and recognized that a strategic partner and funding source helps achieve their business goals more quickly. Financing for the investments and operations is often not at the front of the discussion, but is no less important. LLOG’s core skills are the technical and safety issues and recognized a funding partner would help achieve their business goals more quickly.”

Delta House is the first joint investment under the partnership. In November 2012, LLOG Exploration Company L.L.C. and Blackstone formed a long-term, strategic partnership to expand and accelerate LLOG’s offshore operations in the Gulf of Mexico. LLOG had made four deep water discoveries and was considering appraisal of its extensive prospect inventory of more than 110 offshore leases. Acconia, further commented, “We are very excited to form this long-term partnership under the leadership of Blackstone Energy Partners and LLOG developed a relationship before the Delta House Project was sanctioned. Delta House is the first joint investment under the partnership. In November 2012, LLOG Exploration Company L.L.C. and Blackstone formed a long-term, strategic partnership to expand and accelerate LLOG’s offshore operations in the Gulf of Mexico. LLOG had made four deep water discoveries and was considering appraisal of its extensive prospect inventory of more than 110 offshore leases. 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LLOG Bluewater (jointly owned by Blackstone and LLOG) have executed a three year contract with the SeaDrill West Neptune Drilling Rig which will perform much of the completion work for the Delta House wells.

The partnership is designed to leverage the combined operational and financial resources of LLOG and private equity funds managed by Blackstone to expedite development of LLOG’s assets. In addition, the partnership will assist LLOG grow its Gulf of Mexico asset base through federal lease sale participation, farm-ins and acquisitions. LLOG wants to build on its position as one of the largest private companies in the basin. This strategic partnership is the largest private equity financing executed in the Gulf of Mexico to date. Scott Gutterman, LLOG’s CEO, commented, “We are very excited to form this unique, significant, and long-term strategic partnership with Blackstone. This is the first time that we have joined forces with an equity partner on a Company wide basis, and we cannot imagine a more suitable partner to mark this significant inflection point for LLOG.” This strategic partnership is one of the largest deepwater private equity financings executed in the Gulf of Mexico to date.

LLOG Exploration Company L.L.C.

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Societe Generale, a key partner in the Delta House financing

Societe Generale (SG) is a Joint Lead Arranger of LLOG’s Delta House FPS’s (Delta House) debt financing.

SG facilitated unique financing whereby a major offshore floating infrastructure vessel is financed on the basis of projected cash flows coming from the underlying anchor oil fields. This structure does not require an investment grade leasing counter-party in contrast to traditional financings of offshore assets. The Delta House financing required expertise from two different areas of SG, Shipping & Offshore Reserve Based Finance. By combining financial and technical expertise of these two teams, SG delivered the first financing of this kind in the US Gulf of Mexico.

This transaction highlights the global nature of SG’s commitment and expertise in natural resources and offshore financing. The US Deepwater GOM is a very active area with a number of new large field discoveries and SG is committed to meeting the growing advisory and financial needs of our clients operating in this region.

Societe Generale, your global partner in Oil & Gas and Shipping & Offshore advice and financial solutions

SG is committed to long-term relationships with our clients built on trust. We work to help them succeed in their most important projects. Taking managed risks for them is both our role and our responsibility as a global bank.

SG’s global presence brings many financial skills to its customers. Natural Resources & Energy Financing and Shipping & Offshore Financing are two key pillars of the bank designed to deliver the best advice and financial solutions to our client base. With our unique global Reserve Based Finance platform under the Natural Resources & Energy Financing Group, our professionals are best positioned to provide advisory and financial services on a world-wide basis for upstream oil & gas. Clients may select single field development finance or a borrowing facility based on multiple producing fields.

SG’s Shipping & Offshore Finance provides dedicated global expertise to clients looking to fund construction, purchase or development of vessels and offshore projects. Underlining SG’s position as a leading global energy bank, we have specialist teams dedicated to the LNG and Offshore sectors which include deepwater drillships and FPSO vessels.

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Societe Generale

Houston Energy’s Deepwater Exploration Success Supports Delta House

Houston Energy congratulates LLOG on the successful deployment of the Delta House FPS.

Exploration geoscientists at Houston Energy made initial identification of two of the fields, SOB II (MC 431) and Marmalard (MC 300), which will be produced through the Delta House FPS at startup. Houston Energy supported exploration for the third field in the Delta House area with additional seismic data and analysis.

Based on advanced 3D seismic interpretation, Houston Energy purchased 26 Deepwater blocks from ConocoPhillips in 2008 to secure the three prospects for drilling and development. These prospects were in the same channel levee turbidite system as Houston Energy’s earlier Santa Cruz-Santiago discovery, now a prolific oil producer at MC 519.

Marmalard Field is a turbidite sand draped over a four-way structure with stratigraphic edges. Son of Bluto II Field is a stratigraphic trap on regional dip and is in the eastern portion of the Ariel Field depo-system, Marmalard and SOB II were subtle features recognized by Houston Energy after additional proprietary 3D seismic processing. The third field, like Marmalard, is a turbidite sand over a four-way structure.

Houston Energy has made a total of 9 discoveries in 10 attempts in the Deepwater Gulf of Mexico. The Santa Cruz-Santiago Field has produced more than 22.6 MMbbls oil. Elsewhere in the Deepwater, Houston Energy has made recent oil discoveries at Big Bend (MC 698) and Taggart (MC 816). Big Bend is scheduled to begin production in the third quarter 2015. The Taggart discovery, operated by LLOG, was made in 2013 and is scheduled for completion and hookup in 2016.

Houston Energy and its partners have acreage on 25 undrilled prospects with a resource potential of 1.6 TMB and 1.6 TCF. The blocks include high quality Miocene and Lower Tertiary age oil prospects in the Mississippi Canyon, Atwater, Green Canyon, and Walker Ridge Areas.

Houston Energy is a privately held independent oil and gas company exploring the offshore Gulf of Mexico, South Louisiana, Texas Gulf Coast. The company was formed in March, 1988 by Ronald E. Neal and Frank W. Harrison, III. The mission of Houston Energy is to economically find and develop oil and gas reserves for its partners.

Houston Energy uses an extensive inventory of 3D seismic data to develop drilling opportunities across a range of depths, potential reserve sizes and risk levels. This exploration approach produces a diversified prospect portfolio to match varied investment strategies.

Houston Energy Deepwater Prospects.

As an energy-focused private equity firm and active investor in Gulf of Mexico exploration and production projects for over two decades, Ridgewood Energy has partnered with many of the most successful and pioneering energy companies in the Gulf. Since 2008, Ridgewood Energy’s activities have been primarily focused in the deepwater Gulf of Mexico, where it has participated in a series of major oil discoveries—including the three Delta House fields—and built a leasehold inventory of oil prospects. Ridgewood Energy is also a proud partner in the development of the Delta House Floating Production System. Today, Ridgewood Energy is participating in deepwater projects that have discovered estimated gross reserves in excess of 450 million barrels of oil equivalent (proven plus probable), and holds interests in Gulf of Mexico leases with additional gross resource estimated to exceed 600 million barrels of oil equivalent.

Ridgewood Energy remains committed to being a value-adding, non-operating partner to leading exploration and production companies. Its Houston-based team is comprised of seasoned industry professionals with dedicated geoscience, production and reservoir engineering, land, marketing, and commercial expertise. The Ridgewood Energy team is highly skilled and accomplished in all areas related to successful oil and gas exploration, development, and production, and brings deep, basin-specific knowledge to the evaluation, execution, and management of projects.

With a strategic focus on projects located in the Central Gulf of Mexico, Ridgewood Energy has concentrated the majority of its deepwater investment activity in the Mississippi Canyon, Green Canyon, Ewing Bank, and Atwater Valley, where Ridgewood Energy, either directly or through its joint venture partnerships, has access to state-of-the-art seismic data coverage. Bidding alongside key joint venture partners, Ridgewood Energy was the seventh largest overall participant in the 2014 Central Gulf of Mexico Lease Sale 231. In addition to direct participation at the Lease Sale, Ridgewood Energy also acquires leasehold interests from other energy companies, and participates in attractive drill-ready projects. This multi-channel approach allows Ridgewood Energy to participate in a broad range of projects, and to partner with many of the Gulf’s leading exploration and production companies.

Ridgewood Energy currently manages a strategically focused deepwater Gulf of Mexico investment program of capital commitments totaling approximately $2.5 billion. This program includes a significant investment that Ridgewood Energy manages on behalf of affiliates of Riverstone Holdings LLC, which is one of largest energy-focused private equity firms in the world. Since its inception in mid-2010, Ridgewood Energy’s joint venture with Riverstone has participated in six significant oil discoveries (including the three Delta House Fields). Through its joint venture with Ridgewood Energy, Riverstone affiliates are also partners in the Delta House Floating Production System, and continue to progress additional deepwater Gulf of Mexico exploration and development opportunities.

In 2014, Ridgewood Energy made more than $500 million of capital expenditures related to deepwater Gulf of Mexico drilling and development activities. Over the next several years, Ridgewood Energy’s level of investment in high-value deepwater Gulf of Mexico projects is expected to increase significantly.

In addition to development work related to existing discoveries, Ridgewood Energy’s current inventory of exploration prospects creates visibility to its participation in the drilling of a significant number of exploration wells during 2015 and beyond. In the meantime, Ridgewood Energy’s technical in-house team will continue its active origination work, reviewing opportunities from industry partners, and generating new high-potential prospects.

In the months and years ahead, the team at Ridgewood Energy looks forward to building on its existing relationships—and to forging new partnerships—to develop America’s vital deepwater Gulf of Mexico oil and gas resources. In this pursuit, Ridgewood Energy will remain dedicated to preserving its reputation as a reliable, professional, and value-adding partner to leading energy companies in the Gulf of Mexico.

Ridgewood Energy wishes to thank LLOG Exploration and all of its industry partners who are contributing to the safe and successful development, deployment, and operation of Delta House.

While Ridgewood Energy’s strategy is to be a non-operating partner in major deepwater oil projects, the firm brings enormous technical expertise and validation to the projects in which it participates.
What’s an Indian Tribe doing in the Gulf?

Indian reservations in the western US often have natural resources which can be a source of value. The Southern Ute Indian Tribe has leveraged the natural gas resources on the reservation in the San Juan Basin into a group of successful businesses under an organization called the Southern Ute Growth Fund.

Red Willow Production Company was originally formed to buy back natural gas leases and to upgrade the performance of gas wells on the Reservation. Its success required increased capacity to transport new volumes of gas to the interstate pipelines. The Tribe partnered with the Stephens Group in 1994, and purchased Red Cedar to gather, process and transport natural gas from the Reservation. Kind er Morgan bought out Stephen’s successor in 1998 and has been a great partner for the Tribe.

The Southern Ute Indian Tribe has the unique philosophy guided by long-held values and wisdom. It requires Red Willow to ask, “What will future generations think of us?” LLOG’s record of an operator meets Red Willow’s tough standard. The planning and strategy that resulted in Red Willow’s participation in Delta House is a unique story in Indian Country. The Southern Ute Tribe is a leader in self-determination. They began actively developing their extraordinary natural resource base on the reservation during the 1980s and 1990s. The Tribe’s energy business portfolio originated with the formation of Red Willow Production Company in 1992 and the purchase of Red Cedar Gathering Company in 1994.

Red Willow was originally formed to buy back natural gas leases and to upgrade the performance of gas wells on the Reservation. Its success required increased capacity to transport new volumes of gas to the interstate pipelines. The Tribe partnered with the Stephens Group in 1994, and purchased Red Cedar to gather, process and transport natural gas from the Reservation. Kinder Morgan bought out Stephen’s successor in 1998 and has been a great partner for the Tribe.

Tribal Council adopted an official Financial Plan in 1999 that separated its core government Permanent Fund from its business enterprises, initially energy, and related investment activities. In accordance with the Financial Plan, the Tribal Council enacted a special Plan, the Tribal Council enacted the Growth Fund Implementation Plan in 2000. This plan defined the goals, systems of operation, and consolidated the management of the Tribe’s business activities. The Growth Fund’s business portfolio initially contained only Red Willow, Red Cedar and a few small Tribal Organizations.

The Tribe realized that its energy resources on the Reservation were finite, so the Tribal Council instructed the Growth Fund to diversify operations off of the Reservation and into other ventures and investments. Since 2001, Red Willow has participated in energy projects in nine states, Alberta, and the Gulf of Mexico. Red Willow Production Company has net production of 120 mmscf of gas and 10 mbbl of oil. These figures will increase with the new production from Delta House. It has interests in more than 1900 wells in 10 basins on over 290,000 acres across the U.S.

The Southern Ute Indian Reservation is located in southwestern Colorado on 700,000 acres in the northern half of the San Juan Basin. Production is primarily coal bed methane from the Fruitland Coal, with conventional production from the Mesa Verde, Pictured Cliffs and Dakota formations. The company partners with major operators, including BP, ConocoPhillips and Energen in the San Juan Basin. It has an interest in more than 1300 producing wells on over 148,000 acres of leasehold. Red Willow operates more than 400 wells on the reservation.

The financial success of the energy businesses has allowed the Growth Fund to diversify its portfolio. This diversification includes substantial real estate investments across the US. The GF Properties Group has expertise operating companies in all aspects of real estate, planning, development, investment and project/asset property management. Investments consist of residential and mixed use land for sale and property in retail, office, industrial, apartments and condominiums. As the company’s portfolio continues to grow, the focus is on acquiring income-producing properties, providing asset management services for the properties in the portfolio, and divesting assets as appropriate to optimize investment returns.

The Tribe’s real estate group is majority owner of the Spire condo project in Denver. The Southern Ute Indian Tribe has created an energy, real estate, and private equity portfolio of investments which provide financial security for the Tribe and its members. A huge part of this success comes from working with excellent partners. LLOG is one of the best.
Calypso Exploration – Economically Strong, Technically Savvy, Timely

Calypso Exploration, LLC (CXL) is an independent oil and gas company incorporated in 2000 and was created to find drilling opportunities offshore as a non-operator. CXL is privately owned and works out of cash flow.

The CXL story is one of success in that the company has two employees who are responsible for finding exploration/exploration opportunities in the Gulf of Mexico on both the shelf and in deep water. Since inception CXL has partnered with many notable operators including Shell, ENI, Noble, Murphy, Anadarko, LLOG, Deep Gulf, and GoMex.

The business model employed in deep water is simple: (1) drill seismic data, (2) look for oil, CXL takes care in selecting great partners and Delta House is replete with those. First of all, Houston Energy, Inc. (HEI) was the play generator and because of the great amount of detail that went into the geophysical interpretation, the project has been void of costly surprises. Secondly with LLOG as operator, the project drilling and the FPS design and construction has been very smooth, cost efficient, and on time.

Many wonder how such a small independent can thrive in Deepwater GOM? Well the answer to that is wise investing and great industry relationships. We also have great internal trust relationships within our company and that is a strategic advantage in that our decision making can take place in a very short time frame. Delta House is an example. Because of the quality of work that HEI put into the Delta House play, after an hour and a half of review and discussion, CXL was able to commit to taking a Wi in 4 prospects with just one quick phone call. Not all small companies are alike, and Calypso distinguishes itself with economic strength, technical expertise, very quick analysis, and timely decision making.

The President is Dave Barrett with 40 years of geoscience experience and a graduate of the University of Houston, and the Vice President Land/Business Development is Charlie Barnes with 40 years experience and a graduate of the University of Texas. In addition to the Delta House prospects of Marmalard, Son of Bluoo 2, Son of Bluoo 3 and one other field, other projects producing or capable of producing include Noble’s Raton South MC 292, Deep Gulf’s Odd Job MC 214/215, and GoMex’s Redevelopment Project VR 282/EC 272, all of which are oil projects with CXL’s WI ranging from 10.125% to 37.5%.

Delta House DeepRope® project delivery milestone achieved on schedule

Bexco is a leading European manufacturer of precision engineered fibre rope solutions. From its main production facility located within close proximity to the port of Antwerp, Bexco’s experienced craftsmen and engineers have established the company as a reliable provider of sturdy mooring, towing and lifting rope, made-to-measure for offshore oil and gas, marine and industrial applications.

Bexco designed, manufactured, tested and successfully delivered twenty six reels of DeepRope® with sixteen inserts for the permanent deepwater offshore mooring of LLOG’s Delta House Floating Production Semisubmersible. DeepRope® is a class-certified product. Its production process has been type-approved and certified according to latest API RP 2SM and ISO 9001 standards. In addition, the DeepRope® supplied to Delta House was one of the first of its kind to be delivered with the new DNV OSE303 certification on such a large rope size for deployment in the Gulf of Mexico.

Each rope for Delta House measures 1000 metres in length, and is configured to handle a Maximum Break Load (MBL) of 1700 tons. Rope production commenced in mid-May of 2013, with everything completed two weeks ahead of schedule by mid-November and expedited from the rope production facility on 11th December 2013.

Given the harsh environment for mooring as well as strict regulatory requirements stipulated by the Bureau of Safety and Environmental Enforcement (BSEE), Bexco produced a sample DeepRope® for seabed pre-lay testing purposes in the Gulf of Mexico for in the summer of 2012. Several days of testing at sea were carried out with a senior Bexco engineer on site. This included dragging and resting the DeepRope® sample on the seabed, leaving it on the seabed for 24 hours and cycling through boat motions. The posterior DNV visual inspection proved positive and in November 2012 Bexco received seabed pre-lay BSEE approval. The engineered installation processes for DeepRope® were also subjected to the Internmoor mooring installation procedure, and subsequent comprehensive DNV testing was carried out on the sub-rope to perfectly forecast rope behaviour during installation. In order to produce DeepRope® consistently to specification for Delta
Audubon Engineering Solutions – Integrated Topsides Design Required Management and Flexibility

Project Design Scope
Audubon Engineering Solutions was selected by LLOG Exploration Company (LLOG) as the topsides engineering contractor for the Delta House floating production system (FPS) project. Straightforward and reliable design principles as well as a “one size fits most” modular design philosophy set the foundation for this project. LLOG’s goal was to design, fabricate and install the platform in approximately 30 months.

For the Delta House project, the proven EXMAR OPTI™ hull design was scaled-up to meet the new design criteria of a production rate of 80,000 BOPD, 200 MMSCFD and 40,000 BWPD. The topsides deck for Delta House consists of a two-level structure with most of the processing and utilities equipment/systems located on the upper level for ease of fabrication, operation and maintenance. The FPS was designed to have extra capacity and an expandable control system designed to support future production.

The “one size fits most” design philosophy was used in the Delta House equipment layout while considering future platforms. Subsequent floating production systems will use Delta House as a basis for design with minimal changes necessitated by the PVT data. Utility systems and marine systems will not be modified unless new sizing criteria dictates a change in size or location. Production, treating, utility and control systems were designed for ease of operation while meeting the regulatory requirements of the Bureau of Safety and Environmental Enforcement (BSEE) and U.S. Coast Guard; the class-subsidizable hull and confirm topsides compliance with U.S. Coast Guard regulations.

Integrated Design and Project Management Capabilities
As with any topsides design for an offshore production facility, proper communication and coordination protocol among key contractors in the design phase was critical. Audubon Engineering Solutions supported LLOG by providing this important interface management. Key contractors that worked on Delta House included EXMAR Offshore, the hull design company; Kiewit Offshore Services (KOS), the topsides integration and lift contractor; Pinnacle Engineering, the subsea engineering company. The interface management scope included procurement services, expediting services, cost control management, construction management support, integrated scheduling, topsides engineering, commissioning, and Plant Design Management System (PDMS) for design and fabrication support. Audubon Engineering Solutions periodically exchanged PDMS models with EXMAR to check for design accuracy and performed numerous internal model walkthroughs as well as reviews with vendors during the design of this project. Audubon consistently collaborated with all of the key contractors that worked on Delta House to ensure the design remained within allowable tolerances.

LLOG, KOS and other firms involved in the project.

Initial topsides engineering consisted of confirming that the selected OPTI-11,000™ semisubmersible hull design would meet the expected payload requirements of the processing and utility equipment as well as the additional 500-tonne payload required for future equipment (in actuality, over 900 tonnes of future payload was achieved). Tracking weight and platform center of gravity (CG) during the design process was a key metric to ensure the design remained within allowable tolerances.

A single lift of the integrated structural deck and topsides facility to be set on the hull was required to achieve LLOG’s accelerated project schedule. Audubon Engineering Solutions’ topsides design team worked diligently to keep the topsides deck within the stringent lifting requirements of the Heavy Lifting Device (HLD), which had a planned 10,000 short ton lifting configuration for Delta House to account for the weight of rigging and safety factors. Holding the topsides CG within close tolerances allowed for the lifting of the deck without overloading either of KOS’s HLD booms.

During the project, Audubon Engineering Solutions’ experience in design flexibility was tested when new pressure-volume-temperature (PVT) data was received during the topsides detailing phase, requiring the addition of new processing equipment. Due to an unexpected large volume of Natural Gas Liquids (NGLs), a Condensate Stabilization System was necessary to meet the oil sales pipeline VP requirements. An aggressive weight management plan and effective communication between contractors made this significant design change possible without affecting the delivery schedule or preventing the FPS from achieving its future payload goals.

Audubon Engineering Solutions consistently collaborated with the project design firms, fabricators and vendors during the design of this project to deliver on schedule. Additional coordination and expedition of vendors and fabricators ensured equipment construction was completed in accordance with specifications and delivered on time.

About Audubon Companies
Audubon Companies’ affiliates provide integrated engineering, procurement, construction, project management, and automation to the global oil and gas industry. For almost 20 years, Audubon has provided exceptional engineering services in the oil & gas sector.

We understand the client’s needs and solve dynamic project challenges with a flexible approach while delivering unsurpassed quality. Audubon takes pride in providing cost-efficient solutions that offer immediate value and long-term returns.

Our company is dedicated to the safety of our employees and upholds the highest standards. We are committed to practicing rigorous safety standards and maintaining an incident-free, work environment.

Audubon is comprised of four affiliates – Audubon Engineering Solutions, Audubon Field Services, Cimation and Affinity Management Group – and between them we tackle some of the industry’s most complex engineering, technical and operational challenges. Find out how Audubon can help you achieve quality, efficiency and safety.

Delta House Topsides Fabrication / Integration being completed at Kiewit Offshore Services.

Delta House FPS receives the topsides production systems.
Baker Hughes has contributed to LLOG Exploration’s innovative Delta House project by providing drilling and evaluation services for the subsea wells that will tap reservoirs in four Mississippi Canyon blocks. Baker Hughes also will supply products and services for upper and lower completions for the project’s nine wells.

To begin the project, five subsea wells were drilled, evaluated, and temporarily abandoned to await future completion and the arrival of the Floating Production System (FPS). Baker Hughes provided directional drilling services with its AutoTrak™ rotary steerable system. Because the wells would serve the dual purposes of field appraisal and development, LLOG called for a comprehensive program that included a full suite of formation evaluation measurements provided by logging while drilling (LWD) and wireline services.

Seismic While Drilling

The newest and most advanced evaluation technology applied on the Delta House project was the Baker Hughes SeismicTrak™ seismic-while-drilling service, which was used on one of the Delta House wells.

The SeismicTrak service combines use of a downhole sub with redundant sensors and a seismic source on surface to enable operators to update surface seismic models without impeding drilling operations. The SeismicTrak service captures check shot measurements during connections, and transmits the data to surface using mud-pulse telemetry. As an operator adds pipe, seismic operations from surface engage, and the SeismicTrak downhole receiver acquires formation velocity data with no slowdown to the operation. In addition, the system collects check shot data and full vertical seismic profile data in memory for processing after drilling.

The SeismicTrak service acquires data just ahead of the bit so operators can see and estimate distances to bed boundaries, as well as hazardous faults and pore-pressure regions, in real time.

SeismicTrak on Delta House

To improve the depth positioning of surface seismic data, LLOG wanted to obtain a zero-offset check shot survey of its exploratory well, while minimizing nonproductive time (NPT).

To help LLOG achieve its goals, Baker Hughes used the SeismicTrak service to drill and record check shots in the final section of the well.

The resulting borehole seismic data was transmitted in real-time to experienced geophysicists through the Baker Hughes WellLink™ RT internet-based, WITSML-compliant service. The exploratory well surveyed with the SeismicTrak service had an elongated S-shaped profile, terminating in a near-vertical section where the check shots would be taken. Because of the well’s configuration, a “zero offset” could be achieved by hanging the air guns from the rig.

At each check shot, the data were transmitted to town, where Borehole Seismic Group processed the data and delivered first arrival results within 30 minutes, followed by waveform processing display 15 minutes later.

Because the SeismicTrak system could collect data ahead of the bit, its readings showed that the reservoir sand was located 200 ft shallower than the depth indicated by the surface seismic. The shallower depth was confirmed when the bit reached the sand layer ahead of the original prognosis.

After the well reached total depth, the SeismicTrak service acquired more fill-in check shots, recorded in memory at 45-ft intervals, while tripping out to complete the data set. The final memory processing successfully delivered a vertical seismic profile (VSP) image. LLOG used the resulting time/depth information to update the time/depth conversion of the surface seismic model, reducing uncertainty in surface seismic interpretation.

TesTrak Service Used in Two Applications

LLOG employed the TesTrak™ LWD formation pressure testing service to periodically measure sand pressures as the well was being drilled, and enable engineers to adjust mud weights and other parameters to ensure hole integrity, prevent BHA sticking, and keep the well under control. In addition, the TesTrak system was used in the target sand to measure pressure gradients, reservoir fluid pressures, and fluid viscosities. Geologists also could use TesTrak answers to update their models in real time with respect to reservoir connectivity, compartmentalization and sealing fault identification.

LWD Imaging Helps Map Reservoir Structures

The LithoTrak™ density-porosity LWD system was used as a wireline replacement tool, taking bulk density measurements and creating bulk density images to visualize the downhole geology. The LithoTrak system delivers reliable neutron porosity and formation bulk density logs at rapid sampling rates using an innovative downhole acquisition process. The LithoTrak service’s 16-sector borehole image provides detailed information about the structural orientation of bed boundaries crossed by the well. Gamma Ray image logs, acquired with the OrilTrak LWD system, also were used to determine formation dip angles.

The density and Gamma Ray image logs were used to further refine the Delta House earth model by more accurately mapping faults and formation dipping patterns.

Array Processing Improves Resistivity Answers

Baker Hughes employed an advanced method of processing resistivity logging data to help LLOG evaluate the Delta House pay zones.

Data were acquired using the OrilTrak service, which provides dual gamma ray measurements and four resistivity measurements with variable depths of investigation. MPrTEQ™ array processing considers all four resistivity measurements to accurately determine horizontal resistivity. The method also corrects for anisotropy and calculates a qualitative vertical resistivity value to better understand interbedded sand/shale sequences, particularly in high relative dip angles.

Advanced Completions Ready for Deployment

All lower completions will be proven Baker Hughes sand control systems, featuring Excluder™ screens, CMP™ fluid loss control valves, SC-2™ sand control packers, and CK System™ frac extensions. Frac pack treatments will be pumped by a Baker Hughes technology vessel, either the Blue Dolphin™, Blue Tarpon™ or Smi-FRAC™ vessel. Delta House wells completed in 9 7⁄8-in casing with single zones that include Premier™ packers with Striker™ remote actuation, SAF-1™ fluid loss devices and non-sealing telescoping space out joints (TSSO’s) to facilitate connection with the lower completion. Wells completed in multiple zones will include quick connect, SAF-1™ fluid loss devices and sealing TSSO’s.

One Delta House well will be completed in 11 7⁄8-in casing using an intelligent well system. For this unique application, Baker Hughes developed an 11 7⁄8-in Premier packer with feedthrough lines and an 11 7⁄8-in SC-2 packer for the sand control portion of the well. The completion also will include a quick connect and a TSSO.

For more information about Baker Hughes services or products, please call 1-713-439-8600 or visit www.bakerhughes.com.
Cimation – Automation and IT Support from Specification to Commissioning

In 2012, Cimation was awarded Delta House’s automation and IT scope of work, which included the design, execution, startup, and commissioning of the facility’s Programmable Automation Controller (PAC) and Human Machine Interface (HMI) control systems, architecture and configuration of the IT infrastructure, telecommunications engineering, and safety instrumented systems.

Cimation developed automation and IT specifications for Delta House, including HMI designs, network configurations, and standards documentation for use by all third-party vendors. These project-wide standards helped reduce the number of spares LLOG required, increased safety thanks to common communication protocols and fewer points of failure, and simplified system management through design consistency. Due to their in-depth knowledge of the project’s technology requirements, Cimation also served as a witness during factory acceptance tests (FATs) conducted by other vendors.

One of Cimation’s key objectives was to create efficient, reliable automation and IT systems that meet the demands of a complex deepwater platform. To meet these requirements, Cimation opted for a PAC/HMI-based solution that was both cost effective and relatively quick to deploy. Cimation also developed and implemented a virtualized infrastructure for HMI, historian, and other server functions, reducing the space required to support the hardware by allowing three servers to run twenty virtual machines. The virtualized infrastructure resulted in a more robust system with more effectively separated functions, additional redundancy, reduced energy requirements, and less weight. Dedicated Ethernet/IP networks on a redundant ring topology were designed and implemented for remote I/O and Motor Control Center (MCC) integration. This type of network has a very low failure rate, making it a robust option for projects of this magnitude.

Cimation’s Enterprise Data Solutions (EDS) team also provided solutions that allowed LLOG’s operations, engineering, accounting, and management teams to use data from multiple offshore facilities through integration into onshore systems including a consolidated process historian, remote operations center, SCADA system, and accounting systems. Using their skills and expertise as an industry leader in industrial control systems security, Cimation built cyber security best practices into every aspect of automation and IT design, from network security appliances and firewalls to access controls and password protection.

About Cimation

Cimation, an affiliate of Audubon Companies, is an operations consulting company successfully delivering secure technology solutions to the global energy industry by combining automation, industrial IT, cyber security, and enterprise data solutions.

Cimation was proud to provide excellence in integrated automation and IT services on LLOG’s prestigious Delta House project. By developing a valued and trusted relationship with LLOG and the other project vendors, they provided best-in-class solutions for safety, reliability and efficiency through all stages of operations.

Cimation created HMI standards for LLOG Delta House.

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Cimation created HMI standards for LLOG Delta House.

The Delta House Crew Quarters package was packed with amenities, including:

- A weight room, conference room, full-service kitchen and dining room and medical bay.

Civio Completes Comprehensive Crew Quarters Package

Civio Corporation is a global workforce accommodations specialist dedicated to helping people maintain healthy, productive lives while working away from home. Civio offers comprehensive solutions for housing hundreds or thousands of workers with its long-term and temporary accommodations and provides catering, facility management, water systems and logistics services. Civio builds forward-thinking solutions to our clients’ offshore accommodation needs. We offer seaworthy solutions, including custom designs and a diverse rental fleet consisting of 400 portable modules for installation and use on offshore platforms, vessels, salvage/dredging barges and ships.

“Civio was extremely excited and proud to be included in this project,” said Billy Derenbecker, Vice President of Offshore Operations. “The Delta House project marks the beginning of a new chapter, as we continue to expand our product and service offerings into custom designed offshore accommodation solutions.”

Civio completed the Delta House Crew Quarters package in January 2014. This comprehensive 14-month project included the design and fabrication of a 38-person living quarters package, complete with an attached helipad, life boats and an emergency generator. The helipad can handle 12,000 pounds and used for transporting people to and from the shore base. The schedule included a three-month design period in which all structural and architectural plans were completed.

LLOG ran an efficient project and encouraged cooperation among all the contractors. Civio worked closely with Audubon, the topside engineering design firm, to ensure the Crew Quarters Package was on specification for size and weight. That cooperation combined with the experience and expertise of the entire Civio staff made this first-time endeavor finish ahead of schedule. Civic’s team was proud to contribute its part to this successful LLOG project.

Streamlined panel design by Cimation.

The Delta House Crew Quarters package was packed with amenities, including:

A weight room, conference room, full-service kitchen and dining room and medical bay.
DNV GL Classification and Regulatory Approval for Delta House

Proving the US market has options to choose among classification partners in US waters, DNV GL provided classification and verification services to LLOG’s Delta House project for the US Coast Guard (USCG) and BSEE, respectively. Put simply: Making sure LLOG as well as the USCG and BSEE were confident in Delta House meeting all regulatory requirements.

“Being a part of the success that is Delta House is something we are proud of,” says DNV GL’s project manager Raja Roy. “In 2008 we did class the first FPSO in the Gulf of Mexico, BW Offshore Pioneer for the Chirnook field. We wanted to make Delta House another reference project in the Gulf of Mexico. Now everyone knows that you can choose DNV GL and be confident of regulatory approval,” he says.

To meet with all the USCG requirements for the Delta House project, a design basis agreement was developed using the DNV offshore rules. For two years, from early design to sail away, ten people, in the US, Norway and Korea, worked on the classification scope: Making sure the design and construction effectively met the US Coast Guard requirements.

At the same time, another DNV GL team was working in its capacity as Certified Verification Agent (CVA) for BSEE (Bureau of Safety and Environmental Enforcement). Their scope was the structure, mooring and riser. The CVA group had to work independently of the class group, yet at the same time have the necessary overview to capture synergies.

“This was the first project following an explicit statement from the USCG accepting plan review and inspection functions conducted by DNV GL for a floater in the Gulf of Mexico as part of the unit’s certification under Title 33, Code of Federal Regulations,” says DNV GL’s Houston based project manager Raja Roy.

Numerous suppliers and manufacturers were involved in this project and some had not previously worked with DNV GL. DNV GL helped familiarize them with the process. “This went well, and expanded the number of engineering units and major vendors who now know our rules and processes,” says Pari Natarajan, the project manager in the field.

With the Exmar designed hull being built in Korea, and the Audubon Engineering Company designed topside being built in the Kiewit Offshore Services Yard in Ingleside, Texas, the integration of these two parts had to work smoothly. Through effective knowledge sharing processes and interactions, the handover from Korea to Ingleside went without a hitch.

“Owners have expressed a strong desire for choice of classification society for floating offshore installations in American waters and we know there are many owners, designers, operators and yards who would prefer to work with DNV GL. This successful project is further proof that they can do so, confident of legal and regulatory approval,” says Paul Johansen, DNV GL’s Director of Operations for Maritime in North America.

“With local capabilities and expertise DNV GL is a well established alternative and experienced partner for classifying floaters and complex projects in the Gulf of Mexico. We now look forward to address the industry’s needs and desires for increased safety, reliability, cutting edge technology and, of course, reduced downtime. We are confident that both owners and regulatory agencies will benefit from this,” he said.

DNV GL has carried out extensive verification and independent analysis for many GoM floaters throughout the past 20 years, including many high profile failure and accident investigations. DNV GL has a wide portfolio of CVA and development projects for the oil and gas industry in the GoM.

About DNV GL

Driven by our purpose of safeguarding life, property and the environment, DNV GL enables organizations to advance the safety and sustainability of their business. We provide classification and technical assurance along with software and independent expert advisory services to the maritime, oil and gas, and energy industries. We also provide certification services to customers across a wide range of industries. Operating in more than 100 countries, our 16,000 professionals are dedicated to helping our customers make the world safer, smarter and greener.

In the oil and gas industry, DNV GL is the leading technical advisor to the global oil and gas industry. We provide consistent, integrated services within technical and marine assurance and advisory, risk management and offshore classification, to enable safe, reliable and enhanced performance in projects and operations. Together with our partners, we drive the industry forward by developing best practices and standards.

Our people combine industry expertise, multi-disciplinary skills and innovation to solve complex challenges for our customers.

DNV GL

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Delta House: Project management with a personal touch

Long before welders cut the first piece of Delta House steel, Cyrus J. Guidry & Associates (CGA) was part of the project management team. Thousands of talented people contributed to the finished product, but we were there from the start. Back in May 2012, when the Gulf’s newest deepwater platform was little more than spreadsheets and a spot on a map, we were helping to estimate costs, prepare bid packages and lists of bidders. After the bids came in, we helped expedite procurement and made sure that LLOG was getting all the value it expected.

For two years, a dozen of our most experienced Construction Managers and inspectors worked full time at the Kiewit Offshore Services yard at Ingleside. Another 18 CGA people traveled regularly to 134 vendor sites around the United States and Canada, ensuring that the components for Delta House were delivered on time, on spec and fit for purpose. At Ingleside, around the country and offshore, CGA construction managers oversaw every aspect of the job, from safety and environmental care, to fabrication, inspections, transport, installation, commissioning and startup. “We’re a close-knit company with little turnover in staff,” says CGA owner and president Cyrus Guidry. “Our project engineers and inspectors are seasoned problem solvers who average nearly 25 years each in the business. Our people are well respected for their integrity and record of safe operations.”

Cyrus J. Guidry & Associates, established in 2004, has a number of high-profile Gulf of Mexico projects under its belt, including the Who Dat platform, Garden Banks 72, Lucius, and a number of BP Projects (i.e. Thunder Horse, Holstein, etc.). The projects it accepts should be complete by early 2015. Long before welders cut the first piece of Delta House steel, Cyrus J. Guidry & Associates is also being adaptive to market needs. LLOG, the largest private E&P company in the Gulf of Mexico, continues to lead by leveraging standardization of equipment and the latest subsea technology.

Welder Testing and Procedure Qualification

In 2014, CGA expanded its capability by opening its Welder Testing Laboratory in Houma, Louisiana. Here, companies can send welders to become certified in difficult procedures and techniques. Typically, welders spend several days at the facility, first reviewing the procedure, then demonstrating their ability. The welds are then mechanically tested in our laboratory to confirm the quality of the work. All of our testing staff are AWS certified themselves, and welders are certified to AWS, API, ASME and ABS standards. Cyrus J. Guidry & Associates is also becoming ISO 9000 certified. The process should be complete by early 2015.

Leader in Subsea Technology

Since the establishment of a Subsea Alliance in 2008, LLOG and FMC Technologies have continued to successfully deliver subsea systems. The goal of the Alliance is to develop deepwater assets by fostering a collaborative partnership that is flexible and adaptive to market needs. LLOG, the largest private E&P company in the Gulf of Mexico, continues to lead by leveraging standardization of equipment and the latest subsea technology.

Subsea On Demand

A key element of the partnership between the two companies involves FMC Technologies’ Subsea On Demand program, which promotes fast-track development of the field and offers pre-engineered and field-proven equipment that allows subsea tiebacks and revenue streams to have a safe and healthy head start. Subsea On Demand also reduces field development time by maintaining an inventory of standard configurations, including deepwater wellheads, subsea trees, control systems, manifolds, and tie-ins, and the experienced personnel to install them. FMC Technologies goal is to design and produce subsea systems available for quick delivery and installation, reducing the time to first oil.

Enhanced Horizontal Subsea Tree (EHXT)

For Delta House, LLOG’s second floating production system, FMC Technologies installed the 5” Enhanced Horizontal Subsea Tree. Available in 5-inch by 2-inch for 10,000 psi and 15,000 psi applications, the award winning EHXT has the best uptime performance in the industry.

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GATE and LLOG Commission an Environment for Success

Gibson Applied Technology & Engineering, Inc. (GATE) provides technical support and commissioning services to the upstream oil and gas industry. The principal strength of the company is a systems engineering approach to field design and operation that combines technical, commissioning and project management expertise. This takes personnel with a broad knowledge of production systems and an in-depth understanding of detail design, construction, commissioning and operations. The GATE philosophy is to start with the end result in mind and to make sure that all activities remain aligned to the common goal of safety and timely project delivery, startup and operation.

GATE’s scope of work for LLOG’s Delta House project was commissioning the hull and topsides in preparation for first oil. The key for success is the right people. GATE had approximately 50 personnel with a strong mix of project management, commissioning, engineering and technical skills assigned to the project. This team represented the GATE core philosophy of using a multi-discipline team to provide seamless, technical and project management services to Clients.

GATE appreciates LLOG management and staff promoting an environment where best practices were shared and implemented across multiple contractors, teams and disciplines. This was instrumental in the success of the project.

The first milestone for the project was commissioning quay-side to achieve a Temporary Certificate of Inspection (TCOI) from the US Coast Guard. The main activities at this stage included obtaining necessary operating permits. GATE believes this is a “best practice” for successful commissioning.

GATE was pleased to be part of the LLOG team for the Delta House Project. An organized and decisive operator in LLOG, combined with GATE’s approach of engineering-driven project delivery, helped achieve first oil on time and with no safety incidents during commissioning.

Steven Guy, GATE Vice President – Commissioning: “We are very pleased to work with an Operator such as LLOG. When we sign on to a project, GATE delivers full client attention and dedication to ensure the final outcome of steady state operations is achieved safely and professionally. We are an employee minded Company that believes employees’ satisfaction ultimately builds to Client satisfaction.”


InterMoor provided design, fabrication, installation and hook-up of complete mooring system

InterMoor, an Acteon company, provided suction pile design, fabrication and installation, followed by pre-set mooring hook-up of the Delta House Floating Production System (FPS). Delta House was moored in 4,500 ft. of water and is LLOG’s second Exmar-designed Opti™deep-draft, semi-submersible production system in the Gulf of Mexico.

InterMoor’s contract was to design, fabricate and install 12 suction pile anchors, to install 12 pre-set chain/polyester mooring lines, and hook-up the FPS.

Fabrication of the suction piles took place at InterMoor’s 30,000 square-feet facility in Morgan City, Louisiana. The 12 piles were 85 ft. long and 16 ft. in diameter, weighing about 165t each. The piles were designed to be used as permanent anchors for the project.

The installation of the mooring system took place in Q2 2014 in the Mississippi Canyon 254 block, while the hook-up took place in Q3 2014.

One of the challenges of this deep-water installation was the use of a prescribed anchor handling vessel. Because the mooring system was procured early on in the design process, it was necessary to find a solution that would utilize the selected vessel and extend the vessel capabilities beyond what has previously been done with this class of vessel in terms of mooring component size.

Standard design practices were utilized to develop the installation procedures for the suction piles, preset mooring layout, and hookup. A vessel survey was completed well before the installation and the large size of the mooring system components required modifications to the vessel. The length, size, and weight of the lowering line were also optimized. Fixing two points in the design (i.e. vessel and mooring components) independently of one another created challenging circumstances but closely working with suppliers and manufacturers in an iterative process to ensure that the equipment was more efficient, effective, and reliable.

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Website: www.gateinc.com

GATE’s Systems Approach helped to streamline the Systems Completions Process.

GATE lead pre-commissioning activities of topsides prior to integration with the hull.
Early Contractor Involvement enables safety and success

Since Kiewit had previously constructed and installed the topsides for LLOG’s deep-water Who Dat Project, LLOG sought Kiewit’s fabrication experience once again for the larger Delta House Project to ensure a safe, high quality, on-time project. Kiewit fabricated the Delta House topsides structure at its 555 acre yard in Ingleside, Texas. The topsides included several major sub-assemblies including a 5,000 short ton deck truss, topsides modules and equipment with individual components weighing as much as 600 short tons each. These major sub-structures were comprised of five pipe racks, a Production Module (PM), a Compression Module (CM), and a Generation Module (GM), all of which were all fabricated onsite at Kiewit. The fabrication also included 57,000 linear feet (LF) of process piping and 275,000 LF of cable. Using Kiewit’s Heavy Lifting Device (HLD), which is capable of lifting up to 13,000 short tons, Kiewit lifted, set, and integrated the 9,850 ton topsides onto Kiewit’s Delta House FPS. Each module had a 5,000 short ton capacity.

Kiewit’s scope of work involved 1.8 million man-hours and employed 840 craftsmen at the peak of the project. Work started December 2012, and the Delta House Floating Production System (FPS) was ready for transport to location September 2014. The single-level Exmar OPTI-EX topsides design facilitated simpler construction and equipment integration and allowed Kiewit to compress the schedule and deliver on time.

Oceaneering Delivers Power and Control for Seabed Operations

Since it began in 1964, Oceaneering International, inc. has transformed from a small regional diving company into a global provider of engineered products and services. Oceaneering now employs over 13,000 people in 25 countries.

Oceaneering develops products and services for use throughout the lifecycle of an offshore oilfield, from drilling to decommissioning. It is the world’s largest manufacturer and operator of Remotely Operated Vehicles (ROVs), with over 300 systems operating worldwide. The company is also a leader in offshore oilfield maintenance services, workover control systems, umbilicals, subsea hardware and tooling.

This comprehensive life of field approach to projects provides customers with a single, accountable field services contractor that delivers results in accordance with clients’ specifications and Oceaneering standards. LLOG and Oceaneering have been working together for over 10 years. Oceaneering has performed jobs for LLOG ranging from routine inspection, maintenance and repair (IMR) to suction piles, light construction duties and complex pipeline repair solutions requiring extensive engineering and intervention support. LLOG selected Oceaneering for the umbilical installation on the Delta House project. This work includes four (4) umbilical tiebacks from Marmalard North, Marmalard South, Son of Bluto 2 and one other field to the Delta House floating production system (FPS). Each tieback includes installation of a control umbilical along with other distribution hardware such as flying leads and Umbilical Termination Assemblies (UTA). The umbilicals provide power, data and fluids to the well equipment and are an integral part of production operations. Expert engineering teams carefully planned the installation to ensure there were no problems.

The well manifolds are in approximately 6,500 feet of water and required four (4) control umbilicals. One key challenge for this project was installing the lazy-S flotation method to secure the connection of the umbilicals between the Delta House FPS and the seabed. The engineering for using the lazy-S method was important so the cables touched down in the proper locations and did not interfere with any other subsea infrastructure. Oceaneering work scope included installation services and ROV services. Oceaneering provided assets such as the Olympic Intervention IV multi-service vessel, other sub-contracted vessels, Millennium® Work Class ROVs, intervention tooling and other assistance.

Oceaneering will continue to supply a wide range of engineered services and products required to safely support the deepwater efforts of its customers in 2015 and beyond. From developing customized ROV technology to support drilling and vessel-based projects to strengthening subsea products for tooling and installation, Oceaneering will continuously improve and expand its deepwater portfolio.
Pinnacle Engineering – Subsea Systems and Export Pipelines for Delta House

Pinnacle Engineering Inc. and sister company, Pinnacle Project Services, supply complete engineering, procurement, inspection and commissioning services to the offshore oil and gas industry. Our company specializes in cradle to grave solutions for projects ranging from single to complex multi-well fields in any water depth. Pinnacle understands the importance of managing costs, schedules and risks, as well as being committed to providing a valued partner and trusted resource for economical, safe offshore project development.

Since opening our doors in 1993, Pinnacle has remained focused on providing multidisciplinary engineering on scopes ranging from thousands to hundreds of millions of dollars; and locations from shallow marish to the deepwater Gulf of Mexico. With the installation of more than 100 platforms, 250 pipelines and 100 subsea tiebacks behind us, our understanding of how to get a project completed on time and on budget is unmatched. Pinnacle prides itself on innovation, holding over five pending patents related to subsea hardware design.

LLOG Exploration and Pinnacle began their successful relationship in 2000 with the development of their first deepwater tieback in 1425’ water depth. The well was brought online (including planning, purchasing, permitting, installation and commissioning) in under five months. From there, the LLOG projects quickly expanded into more complex fields in deeper water. Some of the more notable include: subsea tiebacks to Shell’s Brutus TLP (16” non-Shell tieback to a Shell floater), W&T’s Maretainor TLP, and BP’s Pompano structure. Most recently the LLOG Who Dat field, a floating production semisubmersible platform (FPS) with three separate subsea fields tied back and capacity to expand. Early 2012 brought about the start of the latest challenge in the LLOG/Pinnacle partnership with the kickoff of the Delta House project. Following the success of Who Dat, LLOG stuck with the concept of a central FPS (Delta House, MC 254 “A”) with multiple remote subsea fields tied back: Marmalard (MC 300), SGB2 (MC 431), and the third field. The location and water depth of the subsea fields (x+5500ft, and FPS x+4500ft), presented a unique challenge to field routing due to the presence of multiple salt domes, steep inclines, heavy faulting and multiple high potential chemo-synthetic areas. Routes were carefully selected to provide predominately uphill flow to mitigate hydrate potential, avoidance of natural hazards and optimize constructability.

Working in hand with LLOG management and flow assurance engineers, the concept of dual, insulated, piggable flowlines connected to mid and end of line manifolds was selected. For the controls, an Ethernet/fiber optic system was selected to better support the large amount of data expected from multiphase flowmeters and well sensors. Umbilical and chemical injection system designs address early and midlife needs and is also designed to be easily expandable for future discoveries.

Pinnacle selected a purchasing and contracting strategy of breaking up awards into smaller pieces that maximize use of a contractor’s core business. The purpose is twofold: it allows the subcontractors to accelerate deliverables and also gives LLOG flexibility to create compact installation schedules that utilize multiple contractor fleet availabilities rather than one single SURF type contractor.

Over 50 different vendors and service providers were coordinated by Pinnacle in the execution of this project. Timely and clear communications in the sharing of interphase details and schedules was critical, with Pinnacle providing the central hub of information. The end result is a world class deepwater subsea development on par with any of its kind.

Seadrill Commissions New Drillship, West Neptune, for Delta House Project

Seadrill is a leading offshore deepwater drilling company. Seadrill operates a versatile fleet of 69 rigs that comprises drillships, jack-ups, semi-submersibles and tender rigs for operations in shallow to ultra-deepwater areas in both harsh and benign environments. With the most modern fleet in the industry, combined with experienced and skilled people, Seadrill provides safe efficient operations, and is a preferred provider of offshore drilling services.

In 2013, Seadrill signed a long-term contract with LLOG for the brand new drillship West Neptune. The West Neptune will go to work on the Delta House project. The initial focus will be on the completion of eight wells followed by the drilling of five additional wells.

The West Neptune is a 6th Generation drillship of the Samsung 12,000 design. Equipped with a DP3 dynamic positioning system and outfitted to work in up to 10,000’ of water. The West Neptune is capable of operating in water depths of up to ‘12,000’ and drilling depths up to 37,000’. As one of the most modern drillships in Seadrill’s fleet, it has numerous high-end features including the latest in safety and control technologies.

To illustrate, the West Neptune includes:

- **Multi-Machine Control** which automates drillfloor processes to simplify workflow for the operator: i.e. racking of tubulars, stand building, and picking up tubulars. These automated systems create a safer work environment as they reduce the dependence on crewmembers to perform those tasks.
- A 165,000-ton Active Heave Compensated Knuckle Boom crane for simultaneous subsea operations during drilling activities; such as, running and retrieval of intervention/Workover Control Systems (IMOCs) and Christmas Trees. This crane allows operations in sea states that could otherwise interfere with progressing work, increasing efficiency for LLOG.
- Outfitted with two complete 7-cavity 15,000 PSI Shaffer NXT Blowout Preventer (BOP) systems. This capability allows the rig to retrieve the operating BOP on the well, and then run the second one, resulting in increased efficiency as it mitigates downtime associated with performing maintenance and repair when there is only one BOP.
- LLOG’s and Seadrill collaborated on a number of changes to enhance the West Neptune’s ability to support the Delta House project. These upgrades targeted completion activities, as this will be the principal focus of the work for LLOG. Examples include:
  - 15,000 Psi dedicated well fracture pipe system for increased efficiency and safety of operations, avoiding the need for temporary rig up of surface lines.
  - Launch and Recovery System (LARS) for subsea deployment of the IMOCs, providing increased operational flexibility.
  - Optimization of well test deck space for improved deck load capacity and area.
  - Installation of a Remote Operated Vehicle (ROV) cursor rail system for heavy weather deployment of the ROV to increase operational windows.

The planning and resulting outcomes of the customization of the West Neptune is a testimony to the cooperative teamwork between LLOG and Seadrill and a commitment to find and implement creative solutions for the specific needs of the Delta House field development. The result is a better-equipped drillship with an improved design: setting the standard by providing LLOG with superior efficiency and safer drilling and completion operations.
Perma-Pipe provides Auto-Therm® GSPU insulation for the LLOG Delta House project using BASF
Elastoshore mercury free polyurethane

Winning Team

Perma-Pipe and BASF are industry leaders supplying thermal insulation solutions for flow assurance for offshore and onshore pipelines and equipment. Auto-Therm® GSPU (Glass Syntactic Polyurethane), Perma-Pipe’s most popular thermal insulation product for offshore applications, was used exclusively for LLOG’s Delta House and prior offshore projects.

Perma-Pipe provides Auto-Therm® GSPU insulation for the LLOG Delta House project using BASF

equipment manufacturers and thermal insulation applicators. In addition to the independent testing, Perma-Pipe and BASF have conducted extensive in-house R&D, testing and application trials.

Perma-Pipe is the leading supplier of GSPU insulation to independent and major oil and gas operators in the Gulf of Mexico. Auto-Therm® GSPU has been supplied to over 30 projects, totaling over 1,350,000 feet (411 km) and holds the world’s record for the deepest insulated flowline for Shell Perdido at 9,627 feet (2,934m) water depth, in service since 2009.

Perma-Pipe also insulates the subsea equipment including: jumpers, PLETs, PLEM’s, manifolds, trees, goose necks, connector covers / doghouses and other equipment for many offshore projects.

BASF’s Unique Mercury Free Chemistry

Working closely together, Perma-Pipe and BASF were the first to develop and offer mercury free GSPU insulation for the offshore industry in 2004. PermaPipe and BASF continue to improve the overall performance, thermal and mechanical properties, and processing methods for Auto-Therm® GSPU.

Auto-Therm® GSPU was developed to provide a combination of excellent material flexibility, low thermal conductivity and optimum temperature performance required for offshore pipelines and subsea equipment. AutoTherm® GSPU is:

• Extremely flexible to meet the stringent requirements for insulated pipeline installation using the reeling method. AutoTherm® has been reeled to a radius as low as 13 feet (4 m) and has successfully undergone low temperature bending trials at -18°F (-12°C).

• The lowest thermal conductivity GSPU insulation available, resulting in less insulation thickness than other products to meet project

thermal performance specifications.

• Proven successful in simulated service conditions for one year at 228°F (109°C) by the SWIS JIP.

With over 35 polyurethane manufacturing locations around the world, BASF is well positioned to supply the global subsea insulation market. With over 110,000 employees and over 1,500 patents filed yearly worldwide, BASF is the world’s largest chemical company and the leader in polyurethane technology.

Perma-Pipe’s Strong Relationship with LLOG

Perma-Pipe has been LLOG’s insulation supplier for their offshore projects including Who Dat, Who Dat extension, Goose, Mandy, GC 141 and others. Working closely with LLOG’s subsea engineering partner, Pinnacle Engineering, LLOG selected Auto-Therm® GSPU to insulate all the flowlines, risers and subsea equipment for Delta House.

Delta House is the largest single project using Auto-Therm® GSPU, consisting of approximately 318,000 feet (97 km) of flowline and riser pipe, and subsea equipment including: 16 jumpers, 8 PLETs, and 4 in-line sleds.

Delta House’s tight schedule required Perma-Pipe to insulate a large quantity of pipe in coordination with the lay contractor’s schedule for spool base welding, reeling and installation. To meet this demanding schedule, Perma-Pipe worked multiple shifts, 24 hours a day for most of the project and coordinated very closely with BASF to ensure on time material deliveries to supply Perma-Pipe without interruption.

BASF manufacturing facilities in Houma, TX and Geismar, LA delivered the polyurethane materials to support this schedule while meeting all material and quality standards and specifications. Through this close coordination, Perma-Pipe and BASF completed the GSPU insulation of the flowline and riser pipe to support the installation contractor’s spool base welding and installation schedule without any disruptions or delays.

BASF’s Patented Production Process

Perma-Pipe’s patented production process was critical for meeting the Delta House schedule. The Auto-Therm® GSPU process is a continuous molding process where the GSPU insulation is applied as the pipe travels through a short stationary mold sized to provide the required insulation thickness. As the pipe travels through the mold the GSPU material is injected into the annular space and cures rapidly before exiting the mold. This method has significant advantages over other GSPU processes including lower tooling costs, higher production, and was very important for the successful execution of the Delta House project.

Perma-Pipe’s continuous molding process is unique in that it allows 80 foot (24m) nominal length pipe to be insulated for quad and lay installation methods reducing the number of field joints in half resulting in significant cost savings and installation time by the offshore lay contractor.

In addition, Perma-Pipe’s New Iberia, LA facility is strategically located near lay contractor spool bases along the Gulf Coast and with access to the intercostal waterway, allowing for quick and convenient delivery of insulated pipe to lay barges in the Gulf of Mexico. This location has also competitively served the West Africa and Brazil markets.

Subsea Equipment Insulation

Perma-Pipe also provides Auto-Therm® GSPU for subsea equipment. In addition to Auto-Therm® GSPU, Perma-Pipe offers Auto-Therm® SI, a silicone insulation suitable for higher temperatures.
Perma-Pipe is a division of MFRI, Inc. a public company listed on the NASDAQ exchange. MFRI has two divisions; Perma-Pipe, Inc. and Midwesco Filter Resources, Inc. Midwesco manufactures fabric bag and cartridge filter elements for a variety of industrial end use markets.

Perma-Pipe and BASF are proud to have been selected by LLOG to be a part of the overall success of the Delta House project.

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Integrity Built In—Fabrication Solutions for the Global Energy Industry

A leading custom-steel fabricator, Spitzer Industries delivers a broad range of steel fabrication solutions for its energy industry customers. When FMC engaged Spitzer industries to fabricate manifolds for the Delta House project, Spitzer industries called upon its experienced workforce to deliver high-quality, custom-designed manifolds. The project was achieved with a zero-incident safety record. In addition to manifolds, Spitzer’s Heavy Fabrication Division provides the offshore oil and gas industry with custom-fabricated subsea tiebacks and topside modules, along with structural weldments, piping, manifolds, PLEX and PEMs, jumpers, suction piles and other large modular components.

Within multiple fabricating disciplines, Spitzer Industries’ engineered package offerings include glycol dehydration, crude oil stabilizer, amine treatment plant, heavy vessels, columns, towers and structural steel to the production, midstream and petrochemical sectors. Behind this diverse fabrication ability are robust project management capabilities for providing engineering, design and support on every order from start to finish.

The company has built a consistent track record of on-time delivery based on a highly skilled workforce. All Spitzer craftsmen are full-time employees, enabling more effective training, competency management and operational continuity. And with a 77-acre footprint in Houston and 535,000 sq. ft. under roof, Spitzer has the space and equipment to tackle even the largest, most complex fabrication projects. Each of its three facilities offers convenient access to major highway, rail and air transportation links. And the Spitzer Waterfront facility on Greens Bayou provides a direct link to the Houston Ship Channel, enabling worldwide shipment of large components while reducing transportation costs to customers.
Technip Plays Leading Role in the Delta House Subsea Development Project

Technip is a world leader in project management, engineering and construction for the energy industry. From the deepest subsea oil and gas developments to the largest and most complex offshore and onshore infrastructures, our 40,000 people are constantly offering the best solutions and most innovative technologies to meet the world’s energy challenges.

On the Subsea side, Technip provides a complete range of world class solutions for deepwater facilities and subsea systems, field development planning to EPCI, including pipeline construction (S-Lay, J-Lay and Reeled pipeline), Subsea Umbilicals, Risers and Flowlines (SURF) and heavy lift services, utilizing the largest and most advanced fleet for construction asset management.

LLOG awarded Technip a substantial contract for the development of the Delta House project, located in the Mississippi Canyon area of the US Gulf of Mexico, in water depths varying from 100 to 2,000 meters (360 to 6,500 feet).

The scope of work included the project management, engineering, installation and pre-commissioning of more than 200 kilometers (124 miles) of infield and export flowlines and risers. The scope also included fabrication of 26 twenty-six subsea devices including Pipeline End Termination structures (PLETS), In-Line Structures (ILS), and rigid jumpers.

Technip’s operating center in Houston, Texas as performed the overall project management and engineering for the project. The infield flowlines and risers (over 60 miles) were fabricated at the Group’s spoolbase in Mobile, Alabama. The offshore installation began in Q2 2014. Technip prepared the field with almost 500 concrete mattresses in anticipation of twenty-one pipeline umbilical crossings along the lay route to Delta House. The Global 1200, Technip’s state of the art S-Lay vessel, was used for fabrication and installation of over 60 miles of export flowlines. The Deep Blue, one of the most advanced pipeline and construction vessels in the subsea industry, was mobilized in the second half of 2014 to install the deepwater infield flowlines and structures.

Wood Group PSN Partners with LLOG on Delta House Startup and Operation a Success

Wood Group PSN employs more than 30,000 people in 40 countries, making us an industry leader in providing contract labor for pre- and post-production operations. In the U.S. Gulf of Mexico, we have more than 3,000 employees performing services and managing operations on over 1,200 Continental Shelf and Deepwater facilities.

A Close LLOG Partnership

Wood Group PSN has been a trusted partner on LLOG offshore facilities since 1995. For nearly two decades, we have provided a variety of services on numerous offshore LLOG Exploration properties. One of the most notable is supporting production operations for Who Da Re-deployable deepdraft semi-submersible floating production unit (FPU), the industry’s first such facility and predecessor to the larger, more complex Delta House FPU. We have been operating Who Da since its first production, in 2011, and will provide similar services to Delta House after startup.

Wood Group PSN’s Roles in Commissioning Ramp Up

Wood Group PSN’s offshore operations & maintenance (O&M) group along with multiple specialty services teams have worked closely with LLOG on the Delta House project for over a year. Throughout the early design phases, we offered expert feedback on the practicalities of the initial design concepts. Each of our primary skillsets came into play – mechanical, electrical, instrumentation, safety, planning, O&M and administrative – all contributing to planning and readiness strategies for the facility’s future production operations.

Operator training was an important step completed during the ramp up toward commissioning and startup. We provided the staffing for future facility operations, assembling an experienced team of project management to craft-level positions. A proven work planning system was specifically created to be implemented at multiple stages from FEED through construction, to hookup, commissioning and startup. Our personnel also collaborated with LLOG to understand the new, sophisticated systems and equipment that will be at the heart of the Delta House operations.

The integrity of inspection packages for submission to regulators is critical and thoroughly scrutinized. In the post-Macondo era, it is imperative that every facet and component on the facility be correctly fabricated, properly assem- bled, non-destructively examined and meticulously tested. We worked closely with LLOG’s safety and compliance departments to assemble a complete inspection package. Once verified, we conducted a final review to ensure its veracity and handed its submission to the United States Coast Guard and Det Norske Veritas.

Safety: A Wood Group Priority

The safety of our personnel and those working around us is our top priority and underscores everything we do.

Recently, we introduced the Wood Group PSN Safety Cocoon, comprised of four protective layers – Aristos, Hazard Awareness, Life Saving Rules and Behavioral Standard. These layers are focal points within our work culture to ensure everyone, everywhere, every day-safe home. Our company-wide safety initiatives distinguish us and are reflected in a 15-year, industry-low Total Recordable Incident Rate (TRIR).

Hookup, Commissioning and Startup Support

Wood Group PSN’s experience in deepwater operations is unparalleled. We adhere to a sophisticated ramp-up plan used for seamlessly moving the project from construction to startup. Our goals are to provide operational readiness, making stage transitions that are both cost effective and safe. As Delta House sails out to its final deepwater destination, Wood Group PSN-trained personnel will be on board to oversee the facility’s final hookup and commissioning. Once first production is reached, our personnel will safely manage the facility continuously through its project lifecycle.