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WELL CAPPING EVOLUTION

RESERVOIR SIMULATION

ARTIFICIAL LIFT

UNCONVENTIONAL RESOURCES

CO_2 APPLICATIONS

FEATURES

Middle East Sour Gas

Offshore Technology Conference Coverage

WELL CAPPING BECOMES An Industry of Its Own

Stephen Rassenfoss, *JPT* Emerging Technology Editor

This capping stack has been reassembled after shipment to Singapore where it will be stationed to serve customers of the Subsea Well Response Project (SWRP) in the region. The unit was built by Trendsetter Engineering whose technicians put it back together as part of a contract to maintain SWRP capping equipment.

The word to describe offshore well capping is more. There are more people being hired to manage more hardware in more places around the world, and there are more things under development.

A niche business within the offshore exploration and production sector has sprung up since the Macondo disaster destroyed the *Deepwater Horizon* in 2010, which killed 11 and flowed for months before it was finally capped. This growing industry is going to be a "lasting and ever-evolving" part of the business, said Kurt Kriter, Americas regional director for Oil Spill Response Ltd. (OSRL), which is one of the interlocking network of industry-owned organizations responsible for this growth.

Oil Spill Response is an industry-owned cooperative whose responsibilities include owning and managing equipment to quickly respond to out-of-control wells around the globe for another group created by nine big oil companies, called the Subsea Well Response Project (SWRP).

The four recently established hubs covering major oil regions around the globe feature four high-capacity capping stacks, which were built using design advice from the engineering departments of the SWRP members. The two highest-performance units can shut off a well flowing at 15,000 psi, and divert up to 100,000 B/D to surface vessels. When the last of the caps is delivered later this year to Brazil by Trendsetter Engineering, it will mark a transition for this business, which has been focused on building capping stacks, going from zero before Macondo to around 20 currently. The focus is shifting toward operations and developing improved response methods.

This year, OSRL is staffing hubs in Stavanger, Norway; Cape Town, South Africa; Angara dos Reis, Brazil; and Singapore, with six in each location, and 10 in its British well response center, said Jan Strom, director of subsea well intervention services for OSRL. The local teams are charged with maintenance and logistics, with support from outside advisors, such as Trendsetter, which has built nine caps, making it one of the largest companies active in this field.

Well capping companies began in the US, with Marine Well Containment Corporation (MWCC) and Helix Well Containment Group (HWCG). They were created to allow offshore exploration companies to share the cost of buying and maintaining the equipment needed to respond to well incidents. Macondo showed the need, and led to US regulations requiring operators to demonstrate they have access to the equipment and expertise needed to stop an offshore blowout. Now governments around the world have similar regulations.

Mexico has ordered a capping stack to cover its deepwater exploration program in its share of the Gulf of Mexico, south of the area where the two US containment equipment companies operate, said Edgar Rangel German, a commissioner on Mexico's National Hydrocarbons Commission. There are still areas around the globe not covered by spill response organizations, including the Middle East and China, but both are reportedly considering their options.

Shell and BP, which are leading members in several capping organizations, have also built their own stacks. Shell has one for the shallow waters of the Arctic and another with a small footprint designed to fit into the cramped spaces beneath a tension leg platform.

Statoil is working on a project to build a new class of Arctic oil rig that will include a capping stack designed for the extreme conditions there, Geil Ove Elkin, head of mobile offshore drilling unit new builds at Statoil, said in a presentation at the 2013 Offshore Technology Conference.

COOPERATIVE CONTAINMENT GROUPS

Marine Well Containment Co.
Members: ExxonMobil, Shell, Chevron, BP, ConocoPhillips, Anadarko, Apache, Statoil, BHP Billiton, Hess
Covers: US Gulf of Mexico

Helix Well Containment Group
Members: ATP Oil and Gas Corp, Deep Gulf Energy, ENI, Energy Resource Technology, LLOG Exploration Co., Marubenei Oil & Gas, Murphy Oil Corp., Noble Energy, Plains Energy, Repsol E&P, Stone Energy Corp., Walter Oil & Gas Corp, W&T Offshore
Covers: US Gulf of Mexico

Subsea Well Response Project
Members: BG Group, BP, Chevron, ConocoPhillips, ExxonMobil, Petrobras, Shell Statoil and Total
Covers: Global from bases in Brazil, Norway, Singapore and South Africa

WHO DOES WHAT IN A SPILL

Cooperation is critical in the plans laid for blowout response, with multiple organizations each filling a role, along with government agencies. The players are

Containment organizations: Generally industry groups that put together the specialized organizations to develop, maintain, and deliver equipment to and from a site.
Examples: Marine Well Containment Group (MWCC), Subsea Well Response Project (SWRP), Helix Well Containment Group (HWCG)

Operating companies: In the event of a spill the well operator is in charge. Many are members of multiple spill response organizations and some majors own capping stacks of their own.
Examples: Shell and Noble Energy recently led spill response drills in the US Gulf of Mexico.

Oilfield fire fighters: Experts in dealing with blowouts will continue to play critical services from clearing out major damage to advising on the steps needed to kill the well.
Examples: Wild Well Control, Boots & Coots

ORSL has built up an inventory of specialized equipment. In addition to the four capping stacks, it has dispersant tool kits stationed in Brazil and Norway that can be flown to the scene of an accident, and it is building up a supply of 5,000 m^3 of liquid dispersant, about 1.3 million gallons' worth.

But as engineers affiliated with the capping organizations develop new methods, their goal is to re-purpose equipment used for other jobs to avoid the high cost of specialized equipment built for emergency response. Containment technology developers are like chefs adept at creating a varied menu while only using pasta, sauce, cheese, and meat. What is new is usually a remix of things now used elsewhere.

Where possible they figure out ways to shut down wells using equipment used every day for other tasks, which can make it easier to ensure the hardware and the people are ready to perform in the event of an accident. The challenge facing these organizations is the need to develop the ability to improvise solutions as needed, because past disasters are not a good predictor of future ones.

Among the beneficiaries of the growing focus on blowout response preparation has been Wild Well Control. The company, which is one of the oldest and largest of the well-control specialists, has added capping stacks in Aberdeen and Singapore. Its contracts around the globe include working with Mexican state oil company, Pemex, on its well-control response organization.

Workers lower a ram blowout preventer into a capping stack, giving it the power to shut down wells with pressures of up to 15,000 psi. If needed, this system built for the Subsea Well Response Project can produce up to 100,000 BOPD.

Capping stacks are now designed to be broken down into their component parts and shipped in standard shipping containers or skids. Each has been designed to securely transport specific components. While the preferred mode of transport is by boat, Trendsetter has used trucks, and Boeing 747 cargo planes can be used, but they require long runways and heavy lift equipment found in a limited number of airports.

"Anyone can build the hard assets—what we have is people to go with it," said Ben Malina, director of international business development in the Asia-Pacific region at Wild Well. "The industry is better equipped, but the cause of the next crisis may well be different—a production well could go." The one given in this business is, "the circumstances are never the same."

Remixing

The centerpiece of well capping, the capping stack, is at its heart a blowout preventer (BOP). Both are heavy-duty devices capable of cutting off uncontrolled flow from a well. On the higher-performing capping stacks, a BOP is used. (Valves can be used to save weight if the pressure is less.) Capping stack designs have gotten increasingly complex.

The OSRL-owned capping stacks in the four hubs created to serve SWRP's members show the influence of the engineering departments of its nine member companies. OSRL, and others, are looking for a variety of ways to use existing equipment to transport the oil from the ports of the capping stack diverter units to the surface.

One motivation for repurposing is lower costs. A specially built self-standing riser was a big piece of the more than USD 1 billion spent for the equipment inventory held by MWCC, said Marty Massey, the group's chief executive officer.

Now engineers in the companies that started MWCC, as well as others with Trendsetter and Helix Energy Solutions Group, are working on doing more with equipment that is likely to be available at the scene, such as the drilling rigs normally called in.

The task of getting the oil to the surface is conceptually similar to a production test, but the damage caused by a blowout complicates the situation by breaking any connection to the surface, and likely leaving a wellhead that is not able to bear the weight of a riser and the pressure-control equipment.

Several parties are working on ways to securely connect a flowline into a diverter port on a well cap and run that pipe into a nearby drilling riser that has been modified to handle the high-pressure flow that it otherwise could not, said Mario Lugo, chief executive officer of Trendsetter. For example, Trendsetter's working design includes a slim tree normally used for production tests (Schlumberger's SenTree) run through an 18¾-in. BOP. It is lowered in place using pipe that is welded to enable it to handle flows as high as 15,000 psi, Lugo said.

They are considering another option, sending hydrocarbons up the choke and kill lines. If lines normally used for mud circulation prove to be practical, Lugo said it could eliminate the need for added pressure control equipment, such as the test tree and its control system.

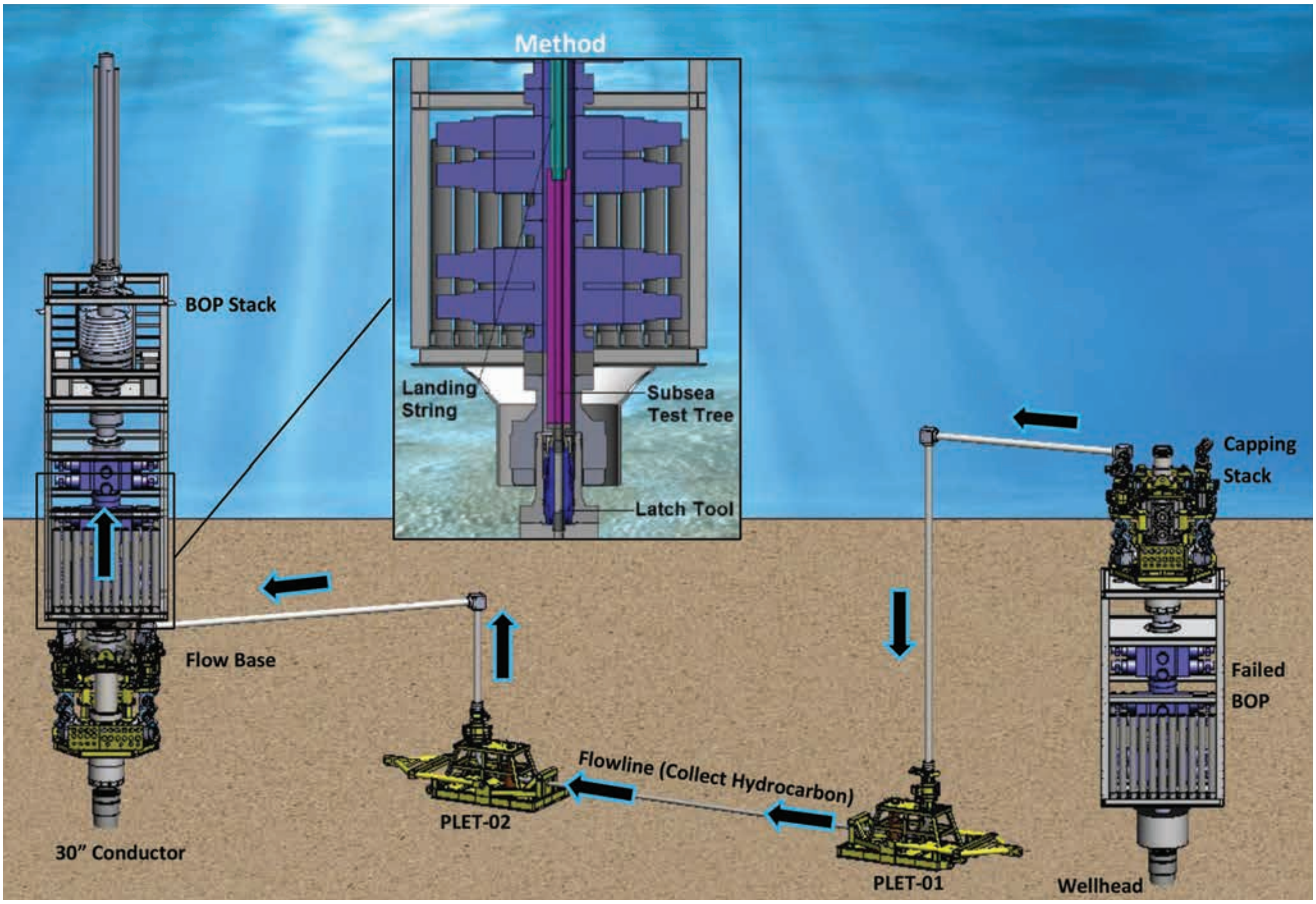
Similar adaptive thinking is going into SWRP's search for a better way to deploy a capping stack in shallow water over a rapidly flowing well. Rather than bringing in a crane able to handle the weight of the capping stack—its 15,000-psi design weighs 130 tons—it is working on a way to do so using a buoyancy system used to install large subsea manifolds in shallow water, Strom said. When in place, its ballast tanks open up letting in water and allowing it to slowly descend on the location of a damaged wellhead.

Drillships are now being equipped with the cranes and production equipment that will allow them to be first responders in the event of a spill and also be of use in well construction or testing.

A Brazilian offshore drilling company, Queiroz Galvao Oil and Gas, has added features to its new drillship that will allow it to better respond to deepwater emergencies. The design includes a heave-compensated crane capable of lowering things weighing up to 135 tons in rough seas to depths of up to 3,000 m. It also has an oil production system capable of burning or offloading 30,000 BOPD, said Gustavo Carvalho, project manager at Queiroz Galvao. The design for the ship, known as the *Brava Star,* goes beyond designs from shipbuilders that are now offering features to improve a drillship's ability to respond to an emergency, or do heavy duty subsea construction jobs.

Another remix of existing technology blurs the functional line between BOPs and the capping stack.

Cameron's Environmental Safe Guard system puts a single BOP on the wellhead that can shear and seal the well if required, allowing the rig to disconnect and move away.



This design offered by Trendsetter Engineering could be used to convert a drilling riser to handle a high-pressure flow of hydrocarbons from a well that has been capped after a blowout. It calls for delivering a flowline with pipeline end terminations to the well site. Those would be tied into the capping stack, and the flow base at the bottom of a drilling riser. Once in the riser hydrocarbons would flow through a test tree commonly used for production testing and up a high-pressure line to the surface. A variation of this design could be used to deliver dispersant from the surface.

At the heart of this capping stack are two gate valves with a capacity up to 10,000 psi built for the Subsea Well Response Project's location in South Africa. Gate valves reduce the weight of the unit, which can be upgraded to 15,000 psi by substituting a higher-capacity blowout preventer in the otherwise standard design.

This would reduce the size of subsea equipment considerably by moving other BOPs used for well control to a floating platform above.

Trendsetter is offering what it calls a pre-installed capping stack. The system, installed on the wellhead below all other flow-control hardware, combines a high-performance BOP with a diverter system to allow production if required by wellbore damage. It has drawn the interest of oil companies planning to explore in arctic areas seeking a quick and sure well shutdown in places where ice can block access for emergency responders.

Drilling

The young business of capping oil wells is developing routines. In the past year, the two US response groups, demonstrated that they could cap a simulated deepwater well in the Gulf of Mexico.

Last summer, Shell led the first drill, attaching an MWCC capping stack onto a simulated well in the Walker Ridge area, which is 200 miles offshore in the central US Gulf of Mexico. The exercise, which was completed in 7 days, required months of planning. Because capping had never been tested this way before, regulators and industry people had to get together and agree on the methods and decide "what success looked like," Massey said.

The test required the stack to be lowered and attached to a simulated wellhead on a piling in nearly 7,000 ft of water and pressurized to up to 10,000 psi and held at that level for 20 minutes. It also required coordinated work by industry and government staff using a communication system offering live video and data over the Internet.

That drill was followed by a second one in which Noble Energy successfully attached an HWCG capping stack on a simulated well in 5,000 ft of water in the US Gulf of Mexico, also in about 7 days.

Given the cost of full-scale deployment drills, those are likely to be fairly rare occurrences but, in 2012, MWCC did about 20 exercises with its member companies to demonstrate its ability to mobilize quickly. When a converted tanker is added to its fleet, special training will be required for the crew members, Massey said.

"The key is a dedicated, capable organization" trained to ensure that everyone knows their jobs and can perform them well, Massey said. **JPT**

DRIVE FOR BOP IMPROVEMENTS SPURS INNOVATION

Buyers of blowout preventers (BOPs) want new ones able to handle higher pressures and cut tougher components. Regulators are also pushing for BOPs with systems that constantly monitor them and can highlight parts likely to fail. And, for everyone, greater reliability is a top priority.

For makers of high-end BOPs, it adds up to more technology development work to do. At National Oilwell Varco's (NOV) Pressure Control Group Research and Development Center there are now 60 people plus contractors working, up from about 12 before it opened 18 months ago, said Frank Springett, pressure control group vice president of engineering at NOV.

To keep up with all the product development programs, NOV applied methods previously used to increase manufacturing productivity, allowing its 13 testing stations to do 40 tests a week, up from 3 to 10 tests a month on the three stations at its previous facility. "There is so much work in pressure control, we have increased our development efforts," Springett said. Much of the work relates to BOPs, but the research facility also works on risers and subsea control systems.

The products of the rise in R&D throughout this segment of the business were seen at the 2013 Offshore Technology Conference (OTC) in Houston. BP executives offered updates on Project 20K, which BP started in 2012 to create the next generation of equipment able to manage pressures as high as 20,000 psi and temperatures up to 350°F.

The hardware exists today to manage those extreme conditions, but BP and other companies are working to take what is now based on cutting-edge engineering and create an expanded supply of components based on standard designs.

Also at OTC, Cameron was showing how big 20K equipment can be in the form of the Evo 20,000-psi BOP, a hulking machine showing the heft needed to meet those extreme specifications. It is not Cameron's first 20K machine—that work dates back a couple years—but remains at the leading edge of pressure-control technology development.

Workers lift a blowout preventer made by National Oilwell Varco that will be used in a capping stack designed to stand up to 15,000 psi.

That imposing BOP at Cameron's OTC exhibit overshadowed two innovations nearby, one looking like an oversized water heater and another a shiny metal tube the size of a small flashlight in a display case.

The bigger one was a new supplementary pressure device developed by Shell and Cameron, called the SPRA for Sea Pressure Reduction Assembly, which lowers the hydrostatic pressure inside the hydraulic system that drives the pistons in a BOP. It creates a high-pressure differential in the hydraulic system, allowing it to create a high-pressure surge using the hydrostatic pressure of the deep ocean to assist the hydraulic system, or if needed, replace it.

Inside the display case was the sensor unit for the Cameron Stack Instrumentation Package. The unit can be installed in the hydraulic system and can tell an operator what position the rams are in at the moment. It is part of a system that includes a black box that keeps a record of operator commands and sensor data, similar to a flight recorder on a plane that often plays a critical role in accident investigations.

The displays are an indication of two research trends: 20,000 is a magic number for a lot of things now and regulators want constant condition monitoring, said Mel Whitby, director of innovative technology and industry relations at Cameron.

GE executives have seen an appetite for BOP innovation. The blind shear ram it rolled out a year ago, which GE said can cut drillpipe connections previous rams could not, was ordered by all the owners of GE BOPs with cavities able to accommodate the upgrade, said Chuck Chauviere, president of drilling for GE Oil and Gas.

"We are talking about a new culture that is becoming predominant in this space," he said. GE is working on systems that take what has been learned in aviation—where monitoring systems alert mechanics to check components that may soon fail—and apply it to subsea equipment data. The goal is going from a "maintenance-based system to prognostication," Chauviere said.

All three of these major BOP makers are working on high-pressure, high-temperature components, improved shearing, and predictive systems. But when it comes to

National Oilwell Varco's Pressure Control Group Research and Development Center was designed and is managed to increase the productivity of the work done there. To increase its productivity, test bays are organized in cells capable to performing a range of tests on multiple pieces of equipment, and on-deck areas nearby ensure equipment is set up and ready for testing when the next test bay is available.

issues causing customers the most pain, Springett said at "the top of the list is downtime."

That has always been a concern but the Macondo blowout changed it as well, because the standard for reliable performance has become more rigorous. While BOPs have many redundant systems, operators are more likely to stop work for repairs if a primary unit goes down and the backup takes over, and that can be costly, he said.

At NOV, the push for more reliable products has led to redesigns making the devices simpler with fewer parts. A component used to stab in choke and kill lines was redesigned, reducing the number of parts from 150 down to one moving part and two seals, he said.

Over time the goal is to reduce the complexity of subsea BOP stacks by creating devices so reliable there can be a reduction in the number of BOPs in a stack, which have grown taller and more complex as more units are added to ensure it does its job even if some parts go down.

One goal for the industry is to use sensors to constantly observe the condition of the BOPs, and ultimately use this information to reduce downtime by observing components likely to fail and replacing them before they go bad.

This change will require convincing regulators and users that data analysis can mean more dependable equipment.

While regulators are quietly considering whether to mandate monitoring, the high cost of downtime offshore can make it harder to convince drilling contractors who buy BOPs that they should buy into monitoring systems. For one, installing a monitoring device inside with a data line running through the wall of the BOP on the way to the control room could run afoul of another prime goal—avoiding leaks.

And no one wants to shut down a project to pull a BOP based on a faulty instrument reading or analysis. "Monitoring adds complexity. If it has an issue, that is a potential [BOP] stack pull, so the monitoring systems being developed must be robust and reliable," Springett said. **JPT**

For Further Reading:

OTC 24076 **Capping Stack Demonstration in the US Gulf of Mexico** *by Marty Massey, Marine Well Containment Company*

OTC 24143 **Driving Innovation Through Collaboration in the Rig Market** *by Geir Ove Eikill, Statoil, et al.*

SPE 163573 **BOP Testing—Qualification Tests, Test Facilities and the Efficient Means of Operating Them** *by F.B. Springett, National Oilwell Varco, et al.*

SPE 163499 **Subsea Cap and Contain Method for a Deepwater Tension Leg Platform** *by John A. Henley, Shell Exploration and Production Co., et al.*

SPE 128477 **20 ksi BOP Stack Development** *by Melvyn F. Whitby, Cameron Drilling Systems*