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BARGE MASTER

INCREASED WORKABILITY WHILE REDUCING COSTS OF OFFSHORE OPERATIONS

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Photo: **Barge Master**

SPOTLIGHT: SPECIALISED VESSELS

North Sea solution

EASY COMMUTE: The *Kroonborg* vessel was designed to fit Shell's walk-to-work strategy for its smaller southern North Sea gas fields.

Photo: Shell

STEADY LIFT: The bespoke vessel includes a number of technological innovations, including a fully motion compensating crane from Dutch company Barge Master.

Photo: Barge Master

A new maintenance support vessel for Shell's smaller gas fields in the southern North Sea boasts a number of technological innovations, as **Russell McCulley** reports.

The *Kroonborg* vessel went to work this spring in the UK and Dutch sectors of the southern North Sea, where Shell's ONEgas business unit and the Shell-ExxonMobil joint venture NAM operate 56 gas producing platforms, 44 of them unmanned. The bespoke support vessel is a key piece of the company's operational strategy in the region, where production is shifting from mature, declining reservoirs to smaller gas deposits.

That strategy, put in place over the past several years, includes a significant reduction in the use of helicopters to transport maintenance crews, says ONEgas project leader Haije Stigter. The *Kroonborg* serves as both a "walk-to-work" vessel and an efficient way to transport the equipment and chemicals needed to maintain gas production.

"The big reservoirs have been discovered and developed," says Stigter of the mature Southern North Sea basin. "But there are smaller accumulations waiting to be developed. So there are two drivers. With mature assets and declining reservoirs, we continuously need to look at managing our operating costs and field life. And with smaller, newer accumulations, we need to look at optimising our development costs."

About 15 years ago, Shell began moving to marine access-only facilities to cut both operating expenses at mature fields and the cost of exploring new, smaller discoveries. The shift to "minimal facilities" had the "knock-on effect of not having to put a helideck and all the associated equipment on the platform", Stigter says.

The first platforms introduced under the walk-to-work scheme were designed to be visited by "small, fast rescue-type craft, where we could put six people on the platform in quite moderate sea states. And since 2006, we've used motion compensated gangways, initially fitted onto the backs of standard DP-2 platform supply vessels."

The new approach worked well enough, but operations were hampered by inclement weather and sea states. Cranes on the small vessels could not operate when waves exceeded about 1.5 metres, which meant work was mostly limited to the warmer months. Restricted space also made it difficult to transport the significant amount of chemicals needed to maintain production, such as corrosion and hydrate inhibitors.

In 2012, Shell engineers started to toss around ideas for a new service and supply vessel to meet multiple needs. Those early meetings started with a fundamental question, Stigter recalls.

"If we had a blank piece of paper, what would a total solution for our ONEgas operations look like? We not only want to be able to put people on the platform, we also want to put materials on the platform. And wouldn't it be nice to be able to transport the chemicals we need to produce and evacuate wet gas?"

Riding the waves

The *Kroonborg* vessel ticked the right boxes on Shell's wish-list. Measuring 80 metres in length and almost 16 metres in width, the ship has accommodations for up to 60 people, including a crew of 20. Built by Royal Niestern Sander shipyard for owner and operator Royal Wagenborg, the vessel is chartered to Shell for an initial period of 10 years.

The ship sports a fully integrated 22-metre Amplemann gangway that compensates the motion of waves up to 2.5 metres. More unusual is the vessel's motion compensating crane, said to be the first of its kind (see page 21).

"When we signed the contract in 2013, we requested a motion compensated crane on the vessel, but that didn't exist then," Stigter says. As it happens, another Dutch company, Barge Master, was conducting field trials at the time on a motion compensation system that could be configured to work with a large crane. The equipment was much larger than what Shell needed, or what the *Kroonborg's* limited deck space could accommodate.

"It's interesting — you put a demand out into the market, and there will be a company out there to pick up the challenge and start developing a solution," Stigter says. "We found a partner in that respect with Barge Master, which already worked with motion compensation but put all of its technology and knowledge into this motion compensated crane."

The Barge Master crane, as configured for the *Kroonborg*, can lift up to five tonnes 32 metres above sea level at a reach of up to 20 metres or 15 tonnes at a reach of 10 metres. "It's been working quite happily in three-metre seas," Stigter notes — all the more remarkable, he adds, "considering the fact that the crane didn't exist when we signed the contract in June, 2013, but was installed on the vessel late last year. And we've now had a few months working with the vessel, putting it through its paces, and everything works like a dream, within the boundary conditions that we set."

The motion compensation technology increases the weather window for offshore operations from about half of a typical year — the "workability" rate Shell was getting with the smaller vessels — to between 85% and 90%, based on historic metocean data, Stigter says.

The equipment is complemented by a propulsion system comprising two Voith Schneider Propellers and two Voith Inline Thrusters. The system provides the station keeping necessary to transfer personnel and materials safely, Stigter says, and to make use of the vessel's cold start-up capabilities. PG Marine Group, now known as PG Flow Solutions, provided the *Kroonborg's* cold start and inspection, repair and maintenance (IRM) package, a below-deck arrangement of pumps, injection and control systems, a nitrogen generator, umbilicals and hose reels. The below-deck tank installation, said to be the first of its type, »

GAS POWER: *Kroonborg* is the first offshore vessel to sail on GTL fuel.

Photo: Shell

» frees up the 500-square metre deck space for other equipment.

The cold start system allows start-up of high-pressure gas wells up to 425 bar by incorporating a heated monoethylene glycol unit. Without the heating capability, the gas pipelines are susceptible to the Joule-Thomson effect —the extreme cooling of high-pressure gas at start-up of production, which can make the steel brittle, Stigter points out.

Cleaner fuel

In what Shell says is another first, the vessel runs on gas-to-liquids (GTL) fuel, which has made some inroads as a cleaner burning alternative to diesel onshore.

Kroonborg, Stigter says, "represents the first commercial marine application of GTL in the world". Shell, Niestern Sander shipyard and Wagenborg collectively approached the vessel's engine manufacturer, PON Power, and the classification society Bureau Veritas to have the fuel approved for marine applications. "There's virtually no sulfur, no soot emissions," he says. "It's a much cleaner fuel."

Turbulent North Sea waters called for a stable hull design for the walk-to-work vessel. While 33 of the 44 unmanned platforms operated by ONEgas have helidecks, they see little use these days.

"We're using walk-to-work at those locations too, because we can be at the facility at daybreak and leave the location at sunset," Stigter says. To get a sizeable crew to a platform by helicopter would require multiple trips each way. "With a helicopter, you get shorter days, fewer working hours."

Since it doubles as an accommodations unit, Shell requested that the vessel provide as much stability as possible.

"One of the design criteria was that it needed to provide comfort for people who work on the platforms but aren't necessarily seafarers," Stigter says. Niestern Sander worked with hull designer Conoship to develop a design that would work in conjunction with the Voith Schnieder propulsion system to minimise roll, noise and vibration.

While the company has no immediate plans to build additional vessels like the *Kroonborg*, Stigter says the concept could be put to good use in other offshore areas.

"Our operations are not dissimilar to operations in the Gulf of Mexico or South-east Asia," he says. "I'd like to see a world where we don't fly people to platforms, for several reasons. You avoid the frustrations of the probability of not having people and materials on the same place at the same time, for one. And moving people around with vessels is inherently safer than moving them around with helicopters." U

Photo: Shell

"The vessel has been working quite happily in three-metre seas."

Haije Stigter, ONEgas

Lowering the swing load

Dutch technology company Barge Master was still testing its innovative BM-T700 modular motion compensating platform when Shell proposed the idea of a similar, but much smaller, piece of kit for the *Kroonborg* crane.

The BM-T700 consists of three hydraulic cylinders, arranged in a triangle, that work together to compensate heave, roll and pitch — the three of the six degrees of freedom that most affect lifting operations (dynamic positioning or anchoring systems compensate for the horizontal motions surge, sway and yaw). The platform has a payload capacity of 700 tonnes or can accommodate a crane with an average capacity of 160 tonnes at a radius of 12 metres.

The set-up requires considerable space — the platform and foundation together weigh 270 tonnes and the foundation has a footprint of 18 metres x 15 metres. Shell used the BM-T700 system earlier this year to install a permanent bridge between a new depletion compression platform and the existing gas production platform at the Malampaya field in the Philippines (see page 45). But putting a motion compensated crane on the *Kroonborg* required significant reengineering, says Barge Master chief executive Martijn Koppert.

"They said, 'we only need to lift five tonnes at a 20-metre radius, but we don't have a lot of deck space'," Koppert recalls of the initial talks with Shell in late 2012. The company wanted the set-up scaled down to a footprint that would not exceed four metres by five metres. "We said, 'we can make the T700, this triangular platform, a bit smaller. But we will never get to the footprint that you have in mind'. So we had to go back to the drawing board."

Barge Master redesigned the platform "to a more sequential set-up", Koppert says, with two cylinders compensating for roll and pitch to keep the pedestal upright, then one cylinder compensating for heave. "The T700 has many applications, but we had to incorporate that technology into a design specific to a crane, and drastically reduce the footprint. The bigger the area, the better — it was very difficult to concentrate in a small footprint."

Nevertheless, the company was able to design, test and deliver the BM-T40 system for the *Kroonborg* in about 18 months.

"This is the first fully motion compensated crane on the market," Koppert says.

The crane enables the *Kroonborg* to work in close proximity to platforms, in wave heights up to three metres.

"I worked a lot offshore, and often experienced the problem of swinging load," he says. "A heave compensated crane does not eliminate swinging. That's why we came up with the concept of the motion compensated crane."

The technology creates a much wider operating window and increases safety, "and by doing that, you reduce cost tremendously", he says. "The one thing crane operators have to get used to is, when they're sitting in the crane, they're sitting still but the vessel is moving. That's a bit of a strange experience, but they get used to it. Even the guys who normally get seasick can operate this crane." U

CUSTOM CRANE: The motion compensating BM-T40 crane went from the drawing board to ship's deck in just 18 months.

Photo: Barge Master

Photo: Barge Master

"This is the first fully motion compensated crane on the market."

Martijn Koppert, Barge Master

Photo: **Barge Master**

Photos: Shell

Malampaya gets a lift

LINKED IN: Phase 3 of the Malampaya project in the Philippines includes a new depletion compression platform, at left, linked by bridge to the existing shallow-water platform.

A new depletion compression platform at the Malampaya gas field will keep lights burning in Manila for years to come. **Russell McCulley** talks to Shell about the landmark project's latest development phase and the technical and logistical challenges involved.

It is difficult to overstate how important the Malampaya Deep Water Gas-to-Power project is to the Philippines. Since production began in 2001, the joint venture of operator Shell Philippines Exploration and partners Chevron Malampaya and Philippine National Oil Company-Exploration Corporation has generated billions of dollars in revenue for the national government, reduced the country's energy imports by an estimated 30%, and provided a powerful symbol of co-operation between the public and private sectors in a nation eager to promote a business-friendly environment to international investors.

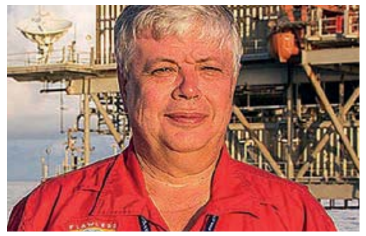
More critically, the development provides between 35% and 40% of the energy supply to Luzon province, which includes Metro Manila and its roughly 12 million inhabitants.

"It is really the only significant upstream resource in the Philippines," says Antoine Bliek, Shell's project manager for Malampaya Phase 2 and 3. "We always say that one lamp in every three in Manila is kept on by gas from Malampaya."

For that reason, when planning began several years ago for Malampaya's second and third development phases, Shell and its partners were under considerable pressure to see that any service interruptions were kept to a minimum.

Malampaya Phase 2, which added two infill wells to maintain pressure and production, was completed last year. Phase 3, to be completed by the end of 2015, includes a new depletion compression platform (DCP), which Shell claims is the first gas platform to be built entirely in the Philippines.

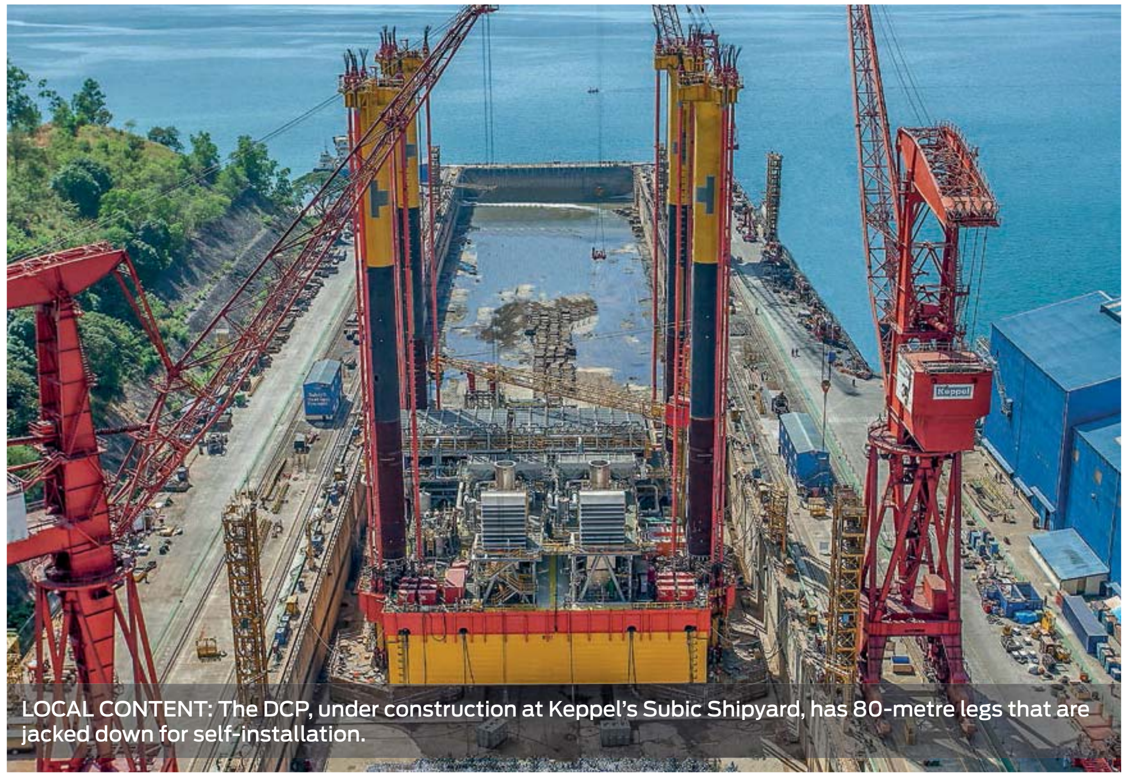
Local capacity to build something on that scale is a relatively new source of pride for the South-East Asian nation. But Malampaya has provided a number of occasions for celebration since



"One lamp in every three in Manila is kept on by gas from Malampaya."

Antoine Bliek, Shell

PROJECT: MALAMPAYA



LOCAL CONTENT: The DCP, under construction at Keppel's Subic Shipyard, has 80-metre legs that are jacked down for self-installation.

SAILAWAY: The DCP being towed out of Subic Bay. More than 1200 workers took part in the two-year construction

STEADY LIFT: Barge Master used its BM-T700 motion compensating lift system, shown mounted on the deck of Boskalis' *Ndeavor*, to install the 43-metre bridge.

Photo: Barge Master

» the final investment decision was announced, with much fanfare, in 1998, nearly a decade after the Camago gas discovery some 80 kilometres north-west of Palawan Island. The adjacent Malampaya discovery in 1992 brought resource estimates in service contract area 38 to 2.7 trillion cubic feet of natural gas and 85 million barrels of condensate.

Inaugurated in 2001, the project's initial phase included five subsea wells — eight at Malampaya and two at Camago — in 850-metre water depths. The wells tie into a 10-slot subsea manifold, gas flows through two 16-inch, 32-kilometre flowlines to a shallow-water concrete gravity-based platform in 43-metre water depths. Processed gas is compressed and exported via a 504-kilometre pipeline to an onshore gas facility near Batangas, in Luzon, which feeds gas to three power plants on the island. The concrete gravity structure has tanks for temporary storage of up to 385,000 barrels of condensate, which is exported to a shuttle tanker through a catenary anchored-leg mooring system installed three kilometres from the platform. The platform was designed for a natural gas capacity of 508 million cubic feet per day and condensate production of up to 32,800 barrels per day.

ON STREAM: The DCP, the original shallow-water platform, and the accommodations unit *Safe Astoria*.

Planning began for Malampaya's third phase around 2010. The front-end engineering and design contract for the self-installing platform went to Fluor Daniel Philippines, with Arup, designer of the existing shallow-water platform, serving as specialist contractor for the substructure. The substructure is an adaptation of the Arup Concept Elevating platform, which uses a pre-installed jacking system to lower the platform's 80-metre legs to the seabed and then lift the topsides clear of the water and into its final position. Boskalis was responsible for seabed preparation, towing and installation of the platform, with Mammoet contracted to provide jacking capability.

Keppel Subic Shipyard fabricated the entire platform in its facility in Subic Bay, Philippines. This required a significant upgrade to the shipyard, including the construction of a 1500-tonne gantry crane, one of the tallest in South-East Asia.

Self-installation

Three factors influenced the final development decisions, Bliek says. The first consideration was the need to minimise service interruptions from the existing platform.

"Second, (Malampaya) sits in 45 metres of water on calcareous soils, so it is very difficult to use a piled foundation. It requires some other type of foundation. And third, it's a very remote site," with little upstream infrastructure or lifting capacity in the region, Bliek explains. "So we didn't want to do any kind of extra lifts, added hook-up and commissioning, things like that.

"We selected a concept that is self-installable, that is constructed as a whole, that could be moved next to the existing platform with minimal disruption of production, and installed quickly without lifts."

Unlike the concrete gravity-based platform, the DCP's 7750-tonne substructure rests on steel footings. The 3300-tonne topsides include two 100% compressors from Siemens driven by Rolls-Royce RB211 turbines, air cooler modules, a utility module, equipment room, pipe rack and a deck crane. The new platform is linked by 43-metre bridge, also designed by Arup, to the original Malampaya platform.

Calcareous sands were not the region's only challenge, says Martyn Turner, Shell's design team lead for the depletion compression project.

"I think it's worth remembering that, as you come farther north in the Philippine Islands, you're in a seismic region and also in a typhoon region. So one of our challenges was designing for both."

To mitigate risk, the DCP had to be designed with an air gap of 23 metres, which meant installation options were limited, he says.

"That was one of the challenges around the installation. The lift barge capability in the region is not geared up for lifts that high. So that was another reason for the selection of a self-installing platform."

Minimal downtime

Shell chose a design that would minimise downtime for the production platform, and timed installation to coincide with a scheduled maintenance shutdown, Turner says.

"We took various decisions, such as going with air coolers, so that we minimised the number of tie-ins. We added our own local equipment to make sure that we could maximise all of our pre-commissioning prior to leaving the Keppel yard," he explains.

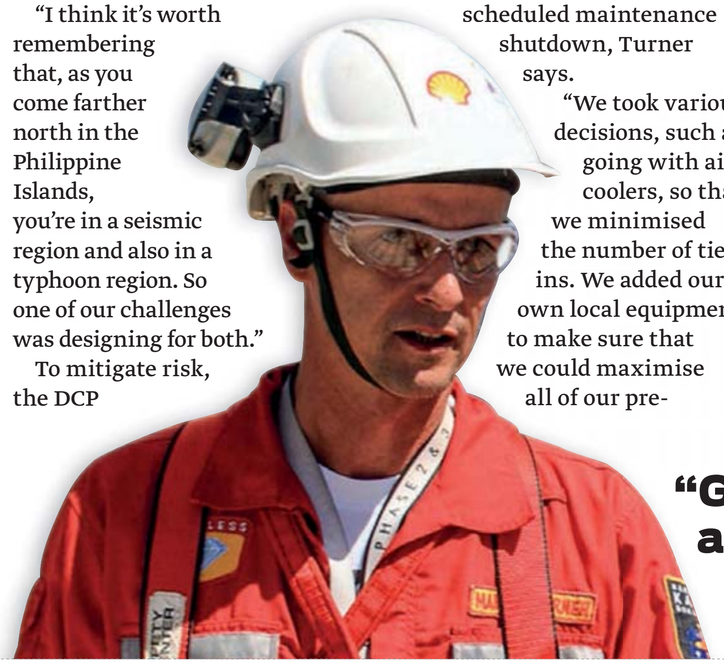
"Interruption would be a huge issue. If you look at more traditional approaches, where you have a number of fields producing into the grid — say, in areas like the North Sea, where you can afford to have a couple of months shutdown to do a tie-in —here, we don't have that luxury. So everything was geared up to make sure we were as complete as we could be before we left the yard."

The platform was installed in February, followed by a planned 30-day maintenance shutdown, during which the major tie-in work was completed. Some 550 workers were offshore at the peak of activity, with Prosafe's accommodations semisubmersible *Safe Astoria* on hand.

During a 48-hour procedure, the platform was lowered into place and temporary bridge access installed. Gas production remained online during the operation. The 150-tonne permanent bridge was lifted into place using strand jacks temporarily installed on the DCP and existing platform. In order to minimise the risk of snatch loading — the sudden tensioning of a slack cable — Boskalis turned to Dutch company Barge Master, and its new BM-T700 motion compensated lifting system (see page 21) mounted on the deck of Boskalis' construction vessel *Ndeavor*. The operation marked the first commercial use of the system, says Barge Master chief executive Martijn Koppert.

More than 1200 workers were involved in the two-year construction of the DCP.

"We were quite keen to maximise local content and do what we could in country," says Bliek. "Capability is growing fast in the Philippines. We supplied our own expertise to the contractors, but I think the fact that the project was delivered as scheduled is proof that, yes, this can now be done. It's quite an achievement." ■



"Gas supply interruption would be a huge issue."

Martyn Turner, Shell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