

# InSide

GustoMSC

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## The oil and gas challenges ahead

THIS EDITION

**Interview with:**  
H.R. Cho, Hyundai Heavy Industries

**The P10,000 class**

**GustoMSC stretches its legs**  
with the CJ80 for 175 m water depths

**Seajacks Zaratan**



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# Preface

This issue of the GustoMSC InSide kicks off with a review of the potential in new, mature and existing worldwide oil and gas reserves. Newly considered areas are the Arctic regions, which not only presents technical challenges but also environmental issues, especially after the Macondo blow-out.

With improved oil recovery and rising oil prices, mature and existing fields can be made economically viable again, although the large onshore shale gas reservoirs will influence the offshore gas activities. These are some of the interesting challenges that our industry is facing.

Since the last quarter of 2010, the newbuild market for drilling units has come back to life. We have seen a boom in newbuild contracts for jack-ups and drillships. We are pleased to have been able to add three CJ70 Jack-ups and five P10,000's Drillships to our own portfolio.

This period also saw the delivery of several of our new build designs, among them the world's largest monohull crane vessel, Oleg Strashnov, owned by Seaway Heavy Lifting. The vessel was built at IHC Merwede shipyard, and GustoMSC delivered the 5,000t offshore crane turnkey.

At the moment of writing we still have 35 units in various phases of construction at several yards worldwide. For GustoMSC this means that a lot of attention is needed from our engineers to support these projects by providing Basic Designs and - in many cases - also to supply the Cranes and Jacking, Skidding and Fixation systems associated

with these designs. Thanks to their dedication we are sure we can serve our clients in an optimum and efficient manner. The newbuilds are spread all over our "3 by 3" matrix. So we are active in the exploration column with jack-ups, semis and drillships, in the construction column with jack-ups and wind turbine installation vessels, and in the production segment with the MOPUs and MOPUstors.

In this issue we are also pleased to introduce Mr. Cho, Executive Vice President of Hyundai Heavy Industries, the builder of our P10,000 Drillship design. Through this interview we hear his views on the offshore and merchant shipbuilding activities of the largest ship-builder of the world.

In the innovation section, which is really the backbone of our company, we discuss advances in the DP assessment tools and the fluid dynamics of a shallow draft semi-submersible.

We wish you lots of pleasure in reading this GustoMSC InSide.

**Han Mommaas,**  
**President GustoMSC**



As shown in the "matrix", GustoMSC has a wide range of mobile offshore units with which to serve the industry. We design Jack-ups, Semi-submersibles and Vessels for a wide range of applications, ranging from exploration (drilling) to construction and production.

# The oil and gas challenges ahead

Worldwide oil and gas reserves will always be a major topic for policymakers, governments and oil companies. Most IOCs are showing declining production rates, though most NOCs, such as Petrobras, are showing increasing production rates. Shell recently announced an increase of its production target to 3.5 million boepd for 2012: a 6% increase against 2010. This article reviews a few potentially important future sources such as the Arctic, pre-salt, shale gas and mature fields, and more particularly the need for additional new drilling rigs to explore these reserves.

By Fernando Frimm and Gerrit Jan Schepman

## The Arctic

The Arctic could hold as much as 22% of all as yet undiscovered oil and gas reserves, according to a US report from 2008. In volume, the reserves could be 90 MM barrels of oil, 1,670 Tcf of gas and 44 billions of NGL. Reviewing the figures more carefully, the top 75% of oil reserves are in the Arctic Alaska, AmerAsia, East Greenland Rift and East Barents Sea. For gas reserves the same regions can be counted, plus West Siberia, Yenisei-Khatanga and West Greenland/East Canada.

Defining the Arctic regions as those above the 67th northern parallel, the countries bordering the region are Russia, Alaska (USA), Canada, Denmark and Norway. Situated on the edge, Iceland also has some interest in the Arctic waters. Discussions on the border lines are ongoing. Norway and Russia recently agreed on the borderline of the Barents Sea after discussing it a couple of decades. This will allow both countries to start the E&P activities in the area. The challenge for the industry is not only on the E&P side, but there will be a big environmental issue to deal with as well. After the Macondo blowout in the Gulf of Mexico in April 2010, the US stopped all deepwater operations and Arctic developments. The question in the public domain is whether the search for oil and gas in the Arctic is worth the environmental and ecological risk. As the Arctic region is above 67° N, different sea and ice conditions are envisaged. There are ice infested waters, which are open to the sea for a certain period of time, like Greenland, Chukchi and Beaufort Sea, or multi-year ice regions or

open water like the Barents Sea.

In summer time, there is 24 hour daylight, but during winter time the area is thrown into darkness. Add to this the cold weather, high waves and wind, and it is easy to realize that human comfort is at stake.

Operators planning their Arctic operations have to deal not only with the technical challenge but also with the permitting issues. One example is the announcement of Cairn Energy to start its 2011 exploration dual drilling program offshore Greenland. Cairn had already implemented a dual rig drilling program in 2010. The dual rig program is set to become the standard for drilling in sensitive waters and is part of an extensive contingency plan, for the unlikely event of an oil spill. In addition to two drilling rigs, the operations were supported by four ice management vessels, two emergency response vessels, two supply vessels and one support vessel.

## Pre-salt

Petrobras has spread the word on the huge reserves claimed for the pre-salt discoveries offshore Brazil. Impressive investment programs have been established to realize the production goal of 5,700,000 bbls/day by 2020. New drilling vessels, FPSOs and support vessels are being ordered. However, pre-salt is not exclusively a Brazilian offshore playground. A long time ago, the continents of South America and Africa were almost connected. The separation started some 165 million years ago. Plate tectonics theory – quite accepted today – suggests that the

geological structures and thus the sedimentary basins will show a similarity. Consequently, West Africa should have large reserves of pre-salt. Sources say that there is, however, some difference: Brazil is dominated by light oil, while West Africa will see a higher percentage of light oil/condensate and wet gas at higher temperatures and pressures. Pre-salt or sub-salt are the terms currently used to describe these reserves.

The definition of sub-salt is exploring beneath an allochthonous salt layer that overlies younger rock. Pre-salt is exploring beneath an autochthonous salt layer that overlies older rock. These potential reserves are found in other places as well, some of which have already been developed. In the Gulf of Mexico, the deepwater sub-salt development started around 2000. A number of these fields are now operational in water depths of up to 8,500 ft with reserves as deep as 32,000 ft. Other regions worth a mention are the Scotia Basin in eastern Canada, and the Majunga Basin offshore Madagascar. The opportunities to enhance the oil and gas reserves through the pre-salt reservoirs could be an incentive for the countries, the operators and the contractors. When will we see the move in exploring the pre-salt reserves in West Africa? Will this be the challenge for the next decade?

## Shale gas

Shale gas and coal bed methane are huge gas reserves distributed worldwide. Wood Mackenzie estimates 280 trillion cubic feet of unconventional gas resource for Europe, India and China alone. Another huge potential is the US and Canadian reserves for unconventional gas resources.

The expectations are that in the next 10 – 15 years this gas can make a significant contribution to supply, with production levels upwards of a minimum of 60 billion cubic meters, according to the study carried out by HIS Cambridge Energy Research Associates (HIS CERA). This production level is half the current shale gas production in North America.

Although large reserves are available onshore, some comments could be made:

- The North American shale gas production has already had a huge impact on a couple of offshore LNG projects. The present production of shale gas reduces the need for supply from abroad. So major trade routes have to be rerouted to - for example - the Far East.



- To be cost-effective, development costs will have to be reduced if Europe is to meet its potential. By and large the availability of the shale gas and the LNG projects from the Pacific could put pressure on the major importers to Europe, especially given the role of Russia.
- Shale gas production is based on the technology of hydraulic fracturing. This technology has been used since the middle of the last century and is the backbone of the production of unconventional gas. Hydraulic fracturing relies on water pressure to create fractures in the rock which allow gas to escape. This technology is also part of a political debate because of its impact on the environment and protection of the underground water reserves. Quebec has recently put hydraulic fracturing on hold and the Marcellus shale gas is also under scrutiny by the US House of Representatives.

Although unconventional gas is an onshore activity, it could favor the total availability of fossil reserves. It could also have an impact on the need for offshore exploration and development in more costly regions like the deepwater and the Arctic.



## Mature fields and new development in the North Sea

Offshore oil and gas production has been established in the Brownfields of the Gulf of Mexico and the North Sea for many decades. Focusing on the North Sea, production in the major oil fields is in decline for all the major countries like Norway, the UK and the Netherlands. As recently reported in the press, production of the four benchmarking setting grades - incl. Forties, Brent, Oseberg and Ekofisk - is to fall to 1.14 million bpd in April 2011, compared to 1.36 bpd in April last year.

Maximum production in many major UK and Norwegian fields was achieved in the mid 1990s for instance. The challenge for the Norwegian government is to maintain its position as an oil and gas supplier. New fields therefore have to be developed and the production of mature fields has to be maintained by means of Improved Oil Recovery (IOR) methods. Statoil, for instance, is looking into a couple of fast-track developments to maintain the present production levels. The same tendency can be seen with the mature fields in the UK and Dutch Continental Shelf. Major operators are divesting, which leaves opportunities for the independents. Another track from major oil companies Shell and NAM is the "SWEEP" project, which stands for "Smart Well Engineering Exploration and Production". The idea is to sweep gas from as many fields as possible and develop satellite or adjacent field opportunities throughout the southern North Sea. Production will be served by special monotower platforms for instance. The exploration and development drilling is intended to be carried out by a dedicated slim-hole drilling jack-up, such as the Swift Drilling's Swift 10. Back to the North, the two main frontier areas for Norway are the

Arctic Barents Sea and the Voring Basin. The last time a giant discovery was announced was in 1997 with the Ormen Lange discovery. At the moment, there are still hopes for the above fields,

but the exploration rates have not been promising. So far, Snohvit and Goliat are the emerging developments. For Norway, however, reality is looming with a sharp decline of the production curve in 2020.

## Towards the need for equipment

Taking a helicopter view of some of the offshore development and the onshore production reserves, some conclusions can be drawn as to the present and future needs for drilling rigs to be jack-ups, ships or semi-submersibles.

After the high newbuild activity and contracts before the financial crisis in 2008, the horizon changed again completely at the end of 2010. The drilling contractors were eager to order rigs and the shipyards were willing to fill their order portfolio. The units wanted most since late 2010 are the jack-ups and drilling vessels. Over 20 floaters with 14 options and nearly 30 jack-ups and an equal number of options have been announced since November 2010. The floaters have mainly been ordered at the Korean yards, plus the first batch of 7 floaters for the 28 Brazilian rigs program in Brazil. The jack-ups were ordered from the Singaporean yards and 9 units from Dalian (DISC).

Focusing more carefully on these orders, some trends become clear. The jack-up market sees a bifurcation. Over 100 jack-ups are stacked, the majority will not return to the drilling market anymore.

The newbuilds fall into three categories:

- The standard 350 ft units.
- The enhanced units with 400 ft water depth capability, 100 ft cantilever reach and 2,000 kips drilling equipment to handle HP/HT wells.
- The deepwater North Sea jack-ups with a 150 m/490 ft water depth and 2,500 kips drilling equipment.

With the introduction of the Swift 10, a new cost effective slim-hole drilling jack-up has been introduced for the mature and marginal fields in shallow water operations for instance in the Southern North Sea.

The floater market remains quite boiling. The present market requirements are leading towards drillships for which recently a number of newbuild contracts have been placed. Two directions are recognized, being the high displacement vessels of about 100,000 tons and the compact vessels with displacements of between 55,000 and 75,000 tons. The compact vessels are of high interest to the contractors and operators as drilling capabilities are remarkably comparable to the large vessels, but with a lower environmental footprint.

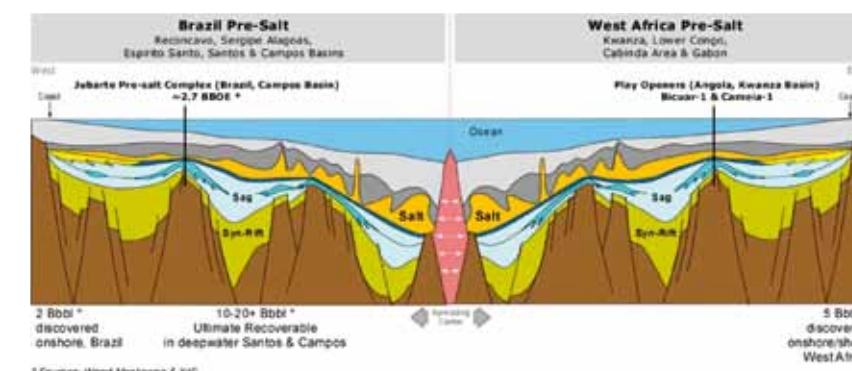
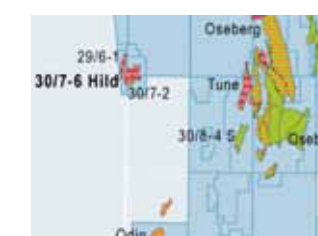
To date, the semi-submersibles have not seen any significant newbuilds. But these numbers will increase as soon as more development drilling will start.

## The GustoMSC drilling rigs

On the floater side, GustoMSC is promoting the compact integrated drilling vessels of the P10,000 and PRD12,000 class. In the P10,000 class, the Deepwater Champion was delivered last year, and a further 7 units are under construction at the HHI shipyard in Korea. The PRD12,000 Qdrill has been developed for the Brazilian market to serve the needs of Petrobras. The first of this series will hopefully be ordered shortly. GustoMSC is offering the DSS series of semi-submersibles in cooperation with Keppel Offshore Marine DTG in the range of the DSS38 to DSS51 class for either the exploration or development drilling.

On the jack-ups side, GustoMSC is enhancing the famous CJ series.

- The CJ46 will remain the standard 350 ft unit.
- The CJ50 will be the 400 ft water depth unit, with enhanced drilling capabilities such as increased cantilever loads and reaches.
- The CJ70 is the "standard" 150 m water depth unit. Maersk Drilling recently signed a contract for 2 units, plus options for another 2, with Keppel FELS, and Seadrill continued with another CJ70 at Jurong. The first Seadrill CJ70 "West Elara" is scheduled for delivery mid 2011.
- The CJ80-X175-A is the latest development in this series. The CJ80 is intended for exploration and development drilling in 175 m North Sea conditions.



Interview with Mr. H.R. Cho,  
Executive Vice President & Chief  
Marketing Officer of HHI:



InSide talks to HHI Executive Vice President & Chief Marketing Officer Mr. H.R. Cho on the company's past, present and future, and in particular on HHI's close relationship with GustoMSC. The thoughts, concerns and forecasts of the largest shipbuilder in the world undoubtedly will be of interest to more than just its clients. The whole marine sector may enjoy listening to where HHI feels it and its industry colleagues will be traveling over coming years. Notwithstanding the somewhat difficult prospects at the present time, convictions are that the sector will rebound strongly. All should benefit.

By Gerrit Jan Schepman

## Hyundai Heavy Industries - ongoing challenges, ongoing innovation

How long has Hyundai Heavy Industries been active as a shipyard in the offshore construction market?

"HHI has been in the offshore construction market since 1976. Our first taste of offshore business development was a huge order for 89 jackets and deck structures for the Open Sea Tanker Terminal, part of the Jubail Industrial Harbor project in Saudi Arabia."

"In the 1980s the Shipbuilding Division embarked on the construction of semi-submersible drilling rigs resulting in the delivery of seven rigs in total. Since then, the Shipbuilding Division has also built many FPSO hulls on a turn-key contract basis."

"Much more recently, the division has been concentrating on the construction of deepwater drillships. Since the successful delivery of the first to Transocean in 2010, there has been keen interest in the operator-friendly GustoMSC P10,000 drillship design from renowned drillers. We have won firm orders from such clients as Noble Drilling and Diamond Offshore."

Tell us a little of the company today: focus, geography, new-build versus repair activities?

"HHI was established in 1972, and commenced

groundbreaking on an empty beach in Ulsan on the southeast coast of the Korean Peninsula simultaneously building two VLCCs. HHI has a global business network in each of its seven divisions; Shipbuilding, Offshore & Engineering, Industrial Plant & Engineering, Engine & Machinery, Electro Electric Systems, Green Energy, and Construction Equipment. Expected 2011 turnover is US\$ 25 bn."

"The Shipbuilding Division has mainly been focusing on merchant business such as supertankers, container ships, and LNG/LPG carriers with a limited portfolio in offshore projects. "The Offshore & Engineering Division, located 7 km away from HHI's main yard in Ulsan, is an independent business division for offshore projects. It has successfully completed more than 170 projects including 100 EPCI (Engineering, Procurement, Construction, Installation) projects for the offshore market. Services include FPSOs, FPU's, semi-submersibles, jack-ups, TLPs, fixed platforms, subsea pipelines, marine terminals, and onshore process facilities."

How many people are working for Hyundai Heavy Industries in rig construction?

"More than 20,000 with an average of 20 years experience each work in the Shipbuilding

Division. About 10,000 of these are directly or indirectly related to building drillships, and the Offshore Division has about 11,000 employees building offshore structures. We clearly have the manpower and expertise for drill rig construction."

What about your own career within HHI and your present role in the company?

"I joined the Ship Sales team of HHI in 1979. From 2003 I worked in the Offshore Division for two years. That experience has been of great help with drillship projects in the Shipbuilding Division. Since 2011, when I was appointed Chief Marketing Officer & EVP of the Shipbuilding Division, I have been responsible for marketing of all types of vessels, including special vessels such as drillships."

"From time to time, I have been assigned to work in overseas offices like London, Oslo, and Tokyo. During this time in overseas offices, I had many opportunities to establish good relationships with clients."

Describe the relationship with GustoMSC from the early days with the CJ70 drilling jack-ups for Maersk?

"HHI delivered two ultra-large jack-up drilling

rigs, Maersk Innovator and Maersk Inspirer, to Maersk Drilling in 2002 and 2004. The design was based on the Marine Structure Consultants CJ70-150MC design developed by GustoMSC. It was specially designed for the harsh North Sea environment."

"But even before delivery of the jack-up rigs to Maersk Drilling, HHI had a relationship with GustoMSC when we entered into a license agreement for the GustoMSC P10,000 deepwater drillship design in the mid-90s. Following our delivery of the first drillship 'Deepwater Champion' to Transocean, the GustoMSC P10,000 design received a lot of interest from many drillers as the most up-to-date and operator-friendly design with advantages such as larger free deck area, job-site maintenance, and better position keeping and high fuel efficiency. And of course we greatly appreciate the continued support from GustoMSC."

What have you seen as the main push for the development of the yard?

"Engineering capability, accommodating client needs, quality, and on-time delivery: all these factors have contributed to our shipyard becoming the No.1 shipyard in the world. HHI has always prepared for changes in the market and new technology including new rules and regulations from the classification societies and regulatory bodies. We always carefully listen to the client's technical requirements and reflect these in our vessel design as much as possible. For example, HHI has already adopted EEDI (Energy Efficiency Design Index) as our standard ship design."

Deepwater Champion



"Perhaps more importantly, I think that the push for development must be our core value. There have been many challenges, both commercial and technical, but HHI has always managed to meet them and keep its position as the world's No.1 shipbuilder. I think that HHI would not exist without the spirit engraved in the hearts and minds of all HHI employees. We call that the "Hyundai Spirit" and it stands for creative wisdom, positive thinking, and unwavering drive."

What are the technology drivers for HHI?

"In general, the technology drivers usually come from our clients and our basic approach is to develop operator-friendly design reflecting their operational know-how and the latest market trends such as greenships and fuel-saving technology."

"In the drillship sector, we recently made modifications to our design to accommodate new technical requirements including 12,000-foot drilling depth and the 7 ram BOP stack. We have been able to be flexible in responding to client technology drivers for drillships, because the GustoMSC P10,000 design has been developed with many provisions for future upgrades and all interface, installation, and integration work between topside and hull performed by the Shipbuilding Division."

Do you focus on certain markets or products such as drilling, production or construction units?

"The Shipbuilding Division has been mainly focusing on merchant shipbuilding with some special projects portfolio such as drillship and LNG carriers. As it is anticipated that deep-sea E&P investment will increase, we would like to focus on the construction of drillships in order to become a total oil & gas solution provider covering all aspects from field development to transportation with close internal cooperation with the Offshore Division."

Would you elaborate on potential new directions or technologies?

"HHI does not spare effort in developing greenship design and fuel-saving technology, nor in adopting new technologies into our merchant vessels in a wish to satisfy our clients. At the moment, HHI is interested in the development of highly efficient fuel-saving technology with low emissions."

Is the company looking for joint developments or is the strategy to develop under own power?

"HHI has sufficient design and engineering manpower to develop new designs with strong support from our in-house maritime and industrial research institutes. HHI is open to cooperation with other companies to jointly develop designs that meet new market trends and technology. In this respect, we welcome any approach to develop new drillship design and technology from GustoMSC."

Looking into the near future, what will be HHI's focus: largest offshore yard or offshore yard with top technology and excellent execution capability?

"So far, one third of HHI's turn-over has been generated by the Shipbuilding Division, and this will continue for the time being. In this respect, merchant vessels will be the main focus of the Shipbuilding Division. However, we will also focus on the sale and construction of drillships in the years to come."

"Meanwhile, our Offshore Division has a great business opportunity, thanks to the current strong demand for offshore structures and floaters followed by high oil prices and increase in E&P investment under the proven capability of offshore project execution and sufficient experiences."

To conclude, what is your outlook for the offshore and marine industry in the near future?

"Shipbuilding and offshore industries mirror the development of global economy and trade. The shipbuilding industry has been in depression since the global financial crisis of 2008, but the global economy and trade will pick up sooner or later. We believe this will result in the recovery of the shipbuilding market before long."

"As the demand for deepwater drilling has been increasing due to high oil prices and demand, it is our opinion that the drillship newbuild market will remain strong. Under these circumstances, the Shipbuilding Division will take the lead in this market. The division will also focus on LNG FSRU, FLNG, CO<sub>2</sub> carriers and CO<sub>2</sub> FSU's. In any case we are sure it will be a busy and exciting future."

# The P10,000 class - effective and compact

By Laurens Claassen and Sjoerd Hendriks

GustoMSC has established a great 6th generation successor to the 1970s Pelican class drillship. These vessels are all built or under construction at South Korean shipyard Hyundai Heavy Industries, the world's largest shipbuilder. This relationship has been long and durable. The 12th GustoMSC P10,000 class drillship is on order for delivery in 2011.



The 3 vessels for Noble Corporation

The Gusto shipyard developed the very first Dynamic Positioning (DP) drillships - the Pelican class vessels - in the 1970s. A total of 12 Pelican class units were built and delivered during the 1970s and 1980s. The most recent Pelican class DP drillships, built in Finland, are still operating successfully in the deepwater fields offshore Brazil. Currently, a total of 10 Pelican class units, some considerably upgraded, are still operating in water depths of up to 6,000 feet. The experience gained from the Pelican class designs was used to develop a new generation of drilling vessels in the 1990s, matching the requirements of the 5th generation rigs. Between 2000 and 2010 the design was matured into a P10,000 drillship design that fulfils the requirements of the 6th generation and beyond. Successfully cooperating with the world's largest shipbuilder, Hyundai Heavy Industries based in Ulsan, South Korea, the first P10,000 drillship, the DNV classed "Deepwater Champion" for Transocean, was delivered at the end of 2010. Two further deliveries to Metrostar Odfjell Drilling, "Deepsea Metro I & II", are scheduled for 2011.

At the end of 2010 and beginning of 2011 the order book of the Hyundai shipyard filled up with three vessels for Noble Corporation and two vessels "Ocean BlackHornet" and "Ocean BlackHawk" for Diamond Offshore. Both drilling contractors have options for additional vessels to be exercised in 2011. Delivery for these units will start in 2013.

GustoMSC has for a long time distinguished itself by approaching drillship design with a different philosophy, resulting in a fully integrated drillship design which embodies all 6th+ generation demands, such as a 10,000-12,000' water depth, dual derrick rated at 4 million lbs, over 200 PAX, or a triple activity deepwater installation crane. But the vessel has only a length of 210 meter between perpendiculars and a moulded breadth of 36 meters, so it is more compact and cost efficient than its competitors. Even the anticipated well control requirements, featuring 7 ram BOP systems, can be accommodated without any major impact on the rig design. The 76,000 t displacement vessel provides a competitive variable deck load and more usable deck space than its larger competitors, guaranteeing maximum flexibility to the owners. The vessel provides a safe working platform for both the people on board and the surrounding environment, and complies with the highest HSE standards.

The P10,000 class drillship features the option to integrate a Thruster Retrieval System (TRS). The Thruster Retrieval System is an example of the intelligent equipment solutions that are being offered to the offshore industry. The GustoMSC TRS enables the vessel to maintain its thrusters on site, even allowing for in-situ thruster replacement. The vessel does not even need to sail to sheltered waters, thus reducing the mob and demob time to zero, so that there is no loss of operating time or income. The P10,000 drillship is fitted with six 5.0 MW thrusters, mounted in canisters for full retrieval with a TRS, in a fully DP3 compliant positioning system. The associated power generation system of approximately 45 MW is divided over three engine rooms located at the aft end of the ship, leaving the prime space of the vessel clear for the drilling plant.

Hyundai Heavy Industries, founded in 1972, has delivered over 1,500 ships to 252 owners in 47 countries, hitting the 100 million dwt mark in 2005. From the 1980s to early 2000s, HHI established a new track record in the drilling industry, realizing a total of 9 semi-submersibles for various drilling contractors, and 2 jack-ups, the GustoMSC CJ70-X150-MC for Maersk Drilling. The latest addition on offer to the market has been the P10,000 drillship. Accomplishing the construction, commissioning of vessel and drilling systems, System Integration Testing program, sea trials and delivery of the Deepwater Champion precisely on schedule, without any major HSE incidents, Hyundai Heavy Industries confirms that it is a reliable shipyard for the construction of a state-of-the-art drillship.



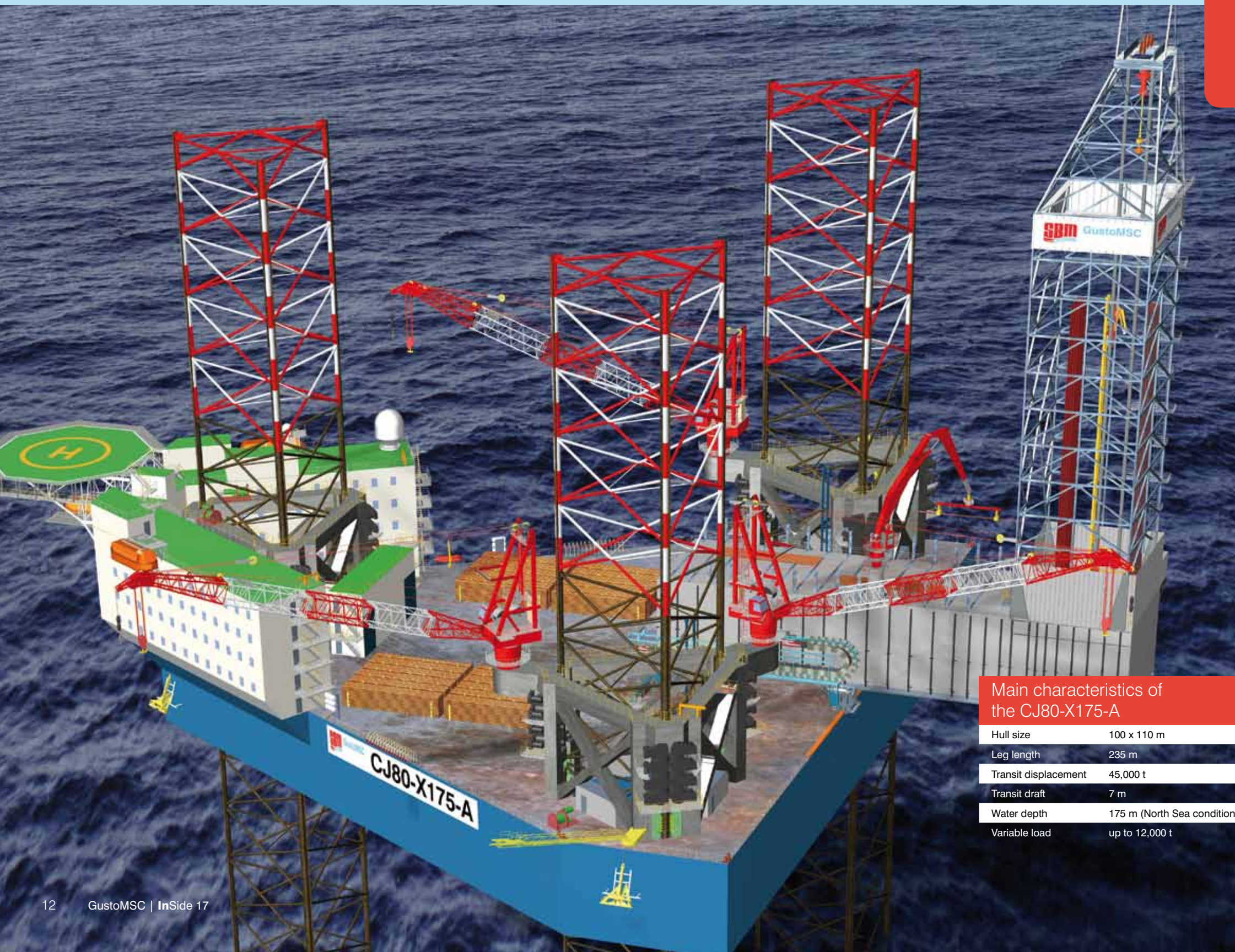
The 2 vessels for Diamond Offshore

# GustoMSC is stretching its legs

## with the CJ80 for 175 m water depths

By Remco van der List and Gerrit Jan Schepman

North Sea oil and gas resources are on the brink of a new era. Production figures are declining and oil and gas fields depleting. So, true to form, logic and their raison d'être, operators are looking at enhancing oil and gas production of existing fields, and especially in water depths down to around 200 m. GustoMSC too plans to play its part and has designed its next step forward – the CJ80-X175-A.



### Main characteristics of the CJ80-X175-A

Hull size	100 x 110 m
Leg length	235 m
Transit displacement	45,000 t
Transit draft	7 m
Water depth	175 m (North Sea conditions)
Variable load	up to 12,000 t

Today a new series of deepwater jack-up units are operational and more are under construction. Jack-up units already operating in the deeper waters of the North Sea are the Maersk Gallant and West Epsilon (both GustoMSC CJ62 units), and the Maersk Innovator and Inspirer (both GustoMSC CJ70 units). Another four CJ70 units are currently under construction: the West Elara at Jurong, scheduled for delivery in Q2 2011, and the recently ordered Maersk TBN1 and TBN2 at Keppel FELS and Seadrill's WestLinus at Jurong Shipyard. This shows the industry's interest in the deeper waters of the North Sea and the preference for jack-ups instead of floaters at these water depths.

Encouraged by the interest in jack-ups for the UK and Norwegian deep waters, GustoMSC has developed the next step forward: the CJ80-X175-A cantilever drilling jack-up. The CJ80-X175-A will operate in water depths of up to 175 m in North Sea conditions. Size-wise the CJ80-X175-A will be the biggest of its class with hull dimensions of 100 by 110 m and with 235 m long legs. Capacity-wise the CJ80-X175-A will be capable of exploration and development drilling. Emphasis has been given to supporting subsea operations for installing subsea X-mas trees, subsea templates etc. The drilling capacity is focused on the GustoMSC patented X-Y cantilever. The X-Y cantilever has a huge capacity with a 1,500 ton combined load capacity over a 100 by 80 ft footprint,

rising to 2,250 t over a 80 x 80 ft footprint. As the 175 m water depth was previously floater territory, the CJ80-X175-A is also equipped to drill with a subsea BOP and a marine riser. The layout of the drill floor and cantilever is such that all different kinds of equipment can be handled from surface BOP's, subsea BOP's to X-mas trees. The spacious 15.24 m (50 ft) wide and 12 m high cantilever provides space for all required drilling equipment. The drilling systems comply with all the modern requirements such as offline stand building, 2,000 kips hook load capacity, a 4 mud pump configuration and a separate oil-based and water-based mud supply and return system.

The CJ80-X175-A is intended for Norwegian waters and the 150 persons accommodation block is therefore fitted with single person cabins.

For a better electrical load sharing and a reduction of CO<sub>2</sub>/NO<sub>x</sub>, the unit is equipped with four 2,500 kW and two 1,750 kW generator sets in two engine rooms. This configuration makes it possible to achieve optimal use of the generator sets during the different modes of operations.

As a leading designer of jack-up drilling units to the latest technology, GustoMSC has again stretched its legs towards deeper waters.



# Seajacks Zaratan - a GustoMSC NG-5500C

By Thomas Lerchenmuller

Future offshore wind farms will be developed much faster than in the past. For GustoMSC the design of wind turbine installation units has long been a focal point with the majority of units operating in this market having their roots in GustoMSC's design offices. Many new build units are of GustoMSC design. Seajacks UK Ltd. likewise regards the turbine installation market as promising and has decided to invest in a new unit. The partnership and story to date.

To date only 2 GW has been installed, with no more than 900 MW in 2010. The plan for 2020 calls for between 30 GW (EER basis) and 65 GW (political targets). Most probably 40 GW will have been installed by 2020. The majority of new wind farms will be in the UK's Round 3 sector, with about 30 GW.

With a view to achieving these objectives, a complete supply chain is to be developed. Elements include:

- The manufacturers of the wind turbines
- The construction companies for the monopiles, jackets and towers
- The transformer station manufacturers
- The installation contractors
- The installation companies for the grid connection
- The connection to the shore
- The development of supply bases

In the above supply chain GustoMSC is mainly serving installation contractors with designs of wind turbine installation units.

One of our clients is Seajacks UK Ltd. In early 2006, Seajacks approached us to customize the GustoMSC NG-2500X design for their proposed newbuilds in the offshore oil and gas business. By the end of 2006, Seajacks and Lamprell had reached an agreement for the construction of the Seajacks Kraken and Leviathan with deliveries in Q1 and Q2 2009. The units were originally intended for work in the oil and gas industry, but the need for Wind Turbine Installation units pulled them into this market. The main crane was upgraded with an additional boom section and a blade rack replaced the helideck.

### The new unit

Seajacks regarded the wind turbine installation market as very promising and decided to invest in a new unit.

Based on the GustoMSC NG-5500C design, the unit was tailor-made to their business model. The Seajacks Zaratan should be an efficient unit to work within two markets:

- Wind Turbine Installation

- Oil and gas (well servicing, maintenance, repair, etc.)

The 'Wrap-around-the-Leg' crane developed by GustoMSC frees up enough deck space to transport 4 complete 3.6 MW turbines, while the capabilities for the oil and gas work have been maintained similar to the NG-2500X design.

In June 2010 Seajacks signed a contract with Lamprell for the construction of the Seajacks Zaratan, making it their third unit to be realized at this UAE based rig builder.

### Fast moving and fast jacking

The unit is designed as a self-propelled unit with full DP2 capability. This enables the unit to perform field moves and jacking operations without tug assistance. For propulsion and DP2 capability the unit is equipped with 3 stern azimuthing thrusters of 1,500 kW and 2 forward retractable, azimuthing thrusters of 2,000 kW. These thrusters will allow the unit to reach transit speeds of between 8 and 9 knots. Arriving on location the unit can maintain position in 1.5 m waves, 1.5 knot current and 15 knot wind in DP2 mode. Jacking speed is essential as a new job at a new location is scheduled for every other day. GustoMSC has developed a patented continuous hydraulic jacking system. The pin-in-the-hole system operates with four yokes per leg, with three engaged and one yoke in the recycle mode. The elevating jacking speed of the platform is 24 m/hr, and lowering 30 m/hr. Leg handling speeds are even higher, up to 40 m/hr. Once it has been elevated, the unit is designed to withstand survival conditions in water depths up to 45 m (winter) or 55 m (summer) on its 85 m long legs.

### The GustoMSC 800 ton main crane

The crane is situated on the SB aft jack-house, with the pedestal integrated into the jack-house structure. The bogie-wheel bearing system was selected to accommodate the large diameter. The crane is equipped with an 85 m long boom to reach the lofty nacelle installation height. Generating capacity of

1,600 kW is required for the 800 ton lifts and slewing operations; this is provided through an electrically driven system.

### The accommodation and safety standards

There are 50 cabins available for the total of 90 persons on board, all with en suite shower/toilet, telephone, TV/DVD and network connection. Galley, mess room, recreation rooms, laundry and stores are provided in the hull. Fire and gas detection systems are provided to ensure the safety of the personnel throughout the unit. Two 90 person capacity life boats are provided at the port and starboard side. Further emergency equipment includes davit launched life rafts for 200% of the total complement and a fast rescue craft/MOB.

### Construction progress

The unit is under construction at Lamprell's Hamriyah yard. The double bottom has been erected and assembled. Leg fabrication has started, and the jacking system components are being manufactured. Fabrication of the pedestal, slewing platform and boom of the 800 ton crane is at the assembly stage. Scheduled delivery Q2 2012.

### Main characteristics

Hull	81 x 41 x 7 m
Legs	85 m
Main deck area	2,000 m <sup>2</sup>
Deck load cap.	10 t/m <sup>2</sup>
Elevated weight	11,000 t
Variable load	2,850 t
Power generation	8,800 kW
Positioning	DP2

### Design conditions

	All year	Summer
Water depth	45 m	55 m
Air gap	14 m	7 m
Max. wave height	17.5 m	10 m
Wind speed	40 m/s	35 m/s
Current	1.2 m/s	1.2 m/s

# Wind Turbine Installation Vessels

## Construction on a worldwide basis

GustoMSC has been selected by a significant number of reputable contractors worldwide. The long standing presence in the offshore market for jack-ups and construction vessels has boosted the number of newbuild GustoMSC-designed Wind Turbine Installation vessels and associated equipment such as jacking systems and cranes.



GustoMSC Offices in the Netherlands



MPI Discovery



MPI Adventure



Sea Installer

At COSCO (Nantong, China)



Jacking systems, in Europe

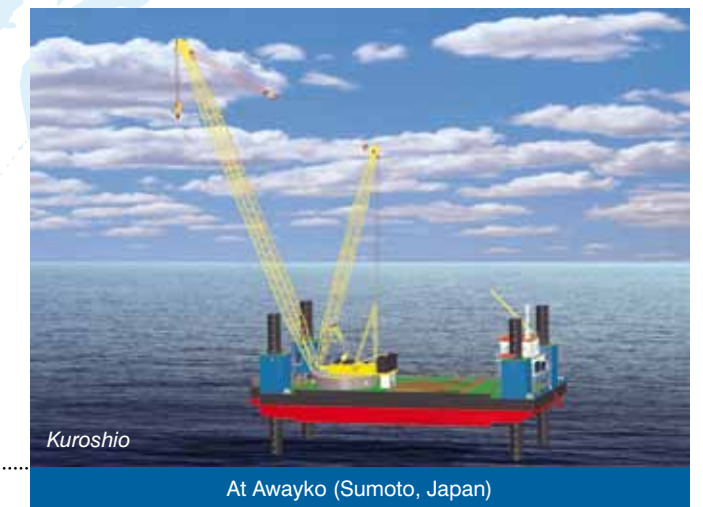


At IHC Merwede (the Netherlands)

Neptune

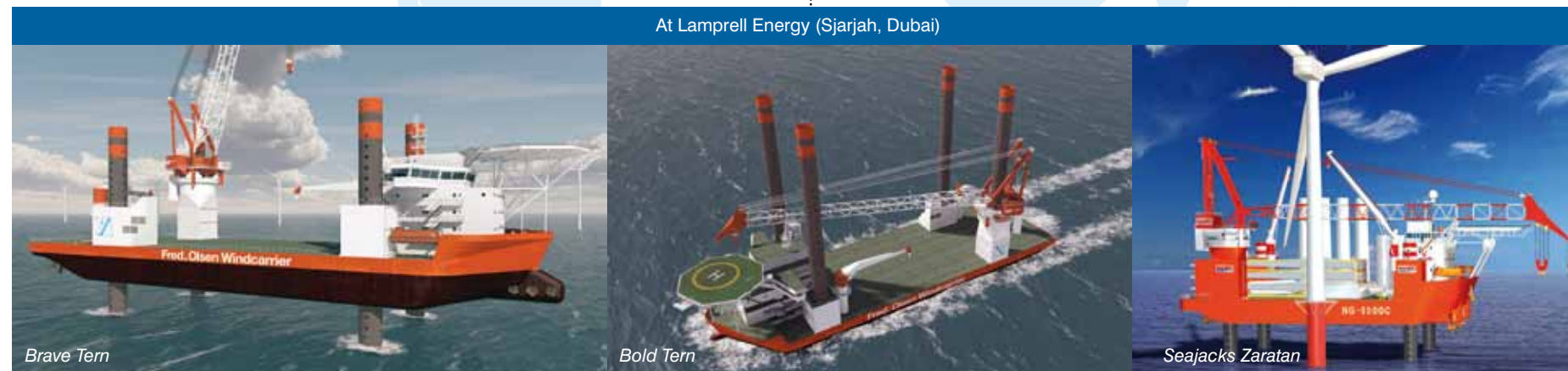


800t and 1,000t cranes (in the Netherlands & China)



Kuroshio

At Awayko (Sumoto, Japan)



At Lamprell Energy (Sjarjah, Dubai)

Brave Tern

Bold Tern

Seajacks Zaratan



At Drydocks World SEA (Tuas, Singapore)

JB-117

Hull L208



## Further advances in Dynamic Positioning assessment tools offer major benefits

By Riaan van 't Veer and Michael Gachet

GustoMSC recently enhanced its Dynamic Positioning (DP) assessment tools to make possible more complex DP capability assessments with significantly greater precision than in the past. Through a coupled DP-motion solver which represents the complete key one line diagram, a vessel's heading and position accuracy can be obtained in a given sea state for any given scenario. A novel approach bridges the fast and efficient static capability prediction and the more realistic and advanced dynamic capability assessment. While details will be presented at this year's Rotterdam OMAE conference in June, the article below highlights the most important findings.

Environmental forces due to current, wind and waves are established for each DP assessment. Wind and current forces are traditionally obtained from a wind tunnel model test. A recent development is the utilization of Computational Fluid Dynamics

(CFD) to calculate the current drag forces and this will become the standard approach when model tests are not available or when, for example, design change variations need to be investigated.

Participation in the THRUST JIP initiated by MARIN, will enable further knowledge of issues such as thruster-hull interactions and thrust degradation due to current to be gained in the near future. The existing approach is to use IMCA or client-specific data to calculate the power-thrust relationship.

Both static and dynamic DP assessments can now be performed using a single DP engine, thanks to the thrust-allocation algorithm based on Quadratic Programming (QP) techniques, carried out in co-operation with the Applied Mathematics Department of Delft University of Technology. This algorithm was developed in-house. Coupling with the AQWA software has meant that an efficient and generally applicable DP simulation environment has become available.

The DP engine defines the Observer, Controller and Allocator. The DP Controller includes a complete description of the vessel power plant with generators, switchboards and propulsors (the key one line diagram). This means that the consequences of any failure of one or more components can be investigated easily. In the time domain, simulations of such a failure can occur at prescribed time events, which allows detailed failure studies and real time dynamic vessel behaviour investigations during the transition time from pre to post-failure. The Allocator distributes the required thrust to compensate all forces over the different thruster units by minimizing the overall power consumption. The core of the Allocator is the QP solver.

The most common (and the traditional) approach to a DP assessment is to define the vessel's capability to withstand the environment by means of a static force equilibrium equation. The result is a capability plot as shown in Figure 2. Given the relationship between the wind speed and the sea state defined by IMCA, the limiting wind speed for which the vessel can maintain heading and position is obtained by equating the delivered overall thrust to the sum of mean environmental forces.

While current forces can be considered time invariant, this is less valid for wind forces and even more so for the low-frequency wave drift forces. The wave drift forces vary significantly over time and the extreme drift forces can be six times as great as the mean forces. The DP system has to compensate for the peak values to minimize position excursions. An example of simulated wind and wave forces on a drillship is given in Figure 1. This illustrates the importance of the time varying wave drift forces in particular, and a time domain simulation is required to account for this.

In the paper prepared for OMAE, a methodology is proposed that links the static capability with the dynamic capability based on the time varying wave physics. A wave drift multiplier is introduced for this purpose, so that the mean wave drift forces can be corrected. Since the factor is derived from time domain simulations, all system characteristics such as thruster rotation speed, thrust increase time and PID controller settings are incorporated in the wave drift multiplier. In the proposed approach, thrusters are not artificially down-graded. Through application of the wave drift multiplier in a static approach, it remains possible to efficiently investigate design alternatives or thruster failures.

Figure 2 offers a comparison between a static capability assessment with and without the corrected mean wave drift forces. The comparison to the full time domain approach shows a fair agreement to the corrected static capability limit. The research performed revealed that a heading and sea state independent wave drift multiplier is a good approximation. This means that only a small series of time domain simulations are required to establish the wave drift multiplier for the vessel under investigation which can then be used throughout.

With these recent advances GustoMSC has obtained a DP simulation tool that describes the complete system key one line diagram and facilitates an efficient study of component failures and design alternatives. Both static capability and dynamic time domain DP simulations can be performed with the same set-up. The wave drift multiplier derived from a series of time domain simulations and static calculations introduces a novel approach that realistically corrects the most important time varying environmental force: the wave drift force. Capability plots based on this method provide a realistic insight in the limiting wind environment at which the vessel can maintain heading and position under Dynamic Positioning.

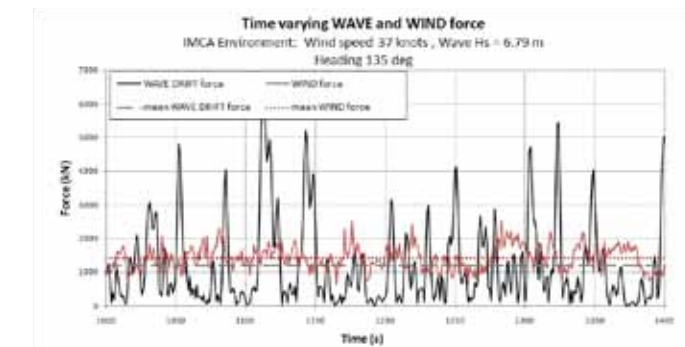


Figure 1: Time varying wind and wave drift forces for dynamic DP simulations compared to the mean forces used in static DP calculations. Drillship P10,000 example in 6 m sea state.

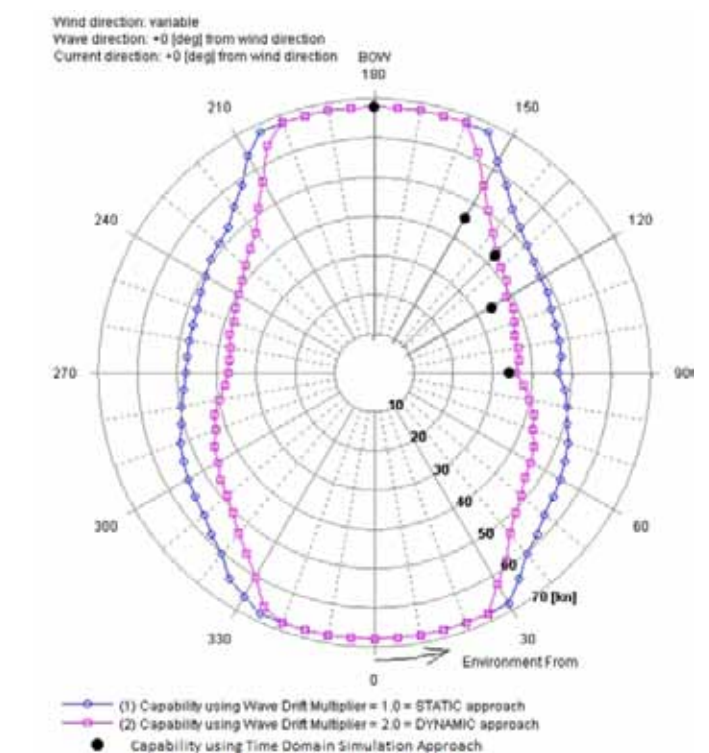
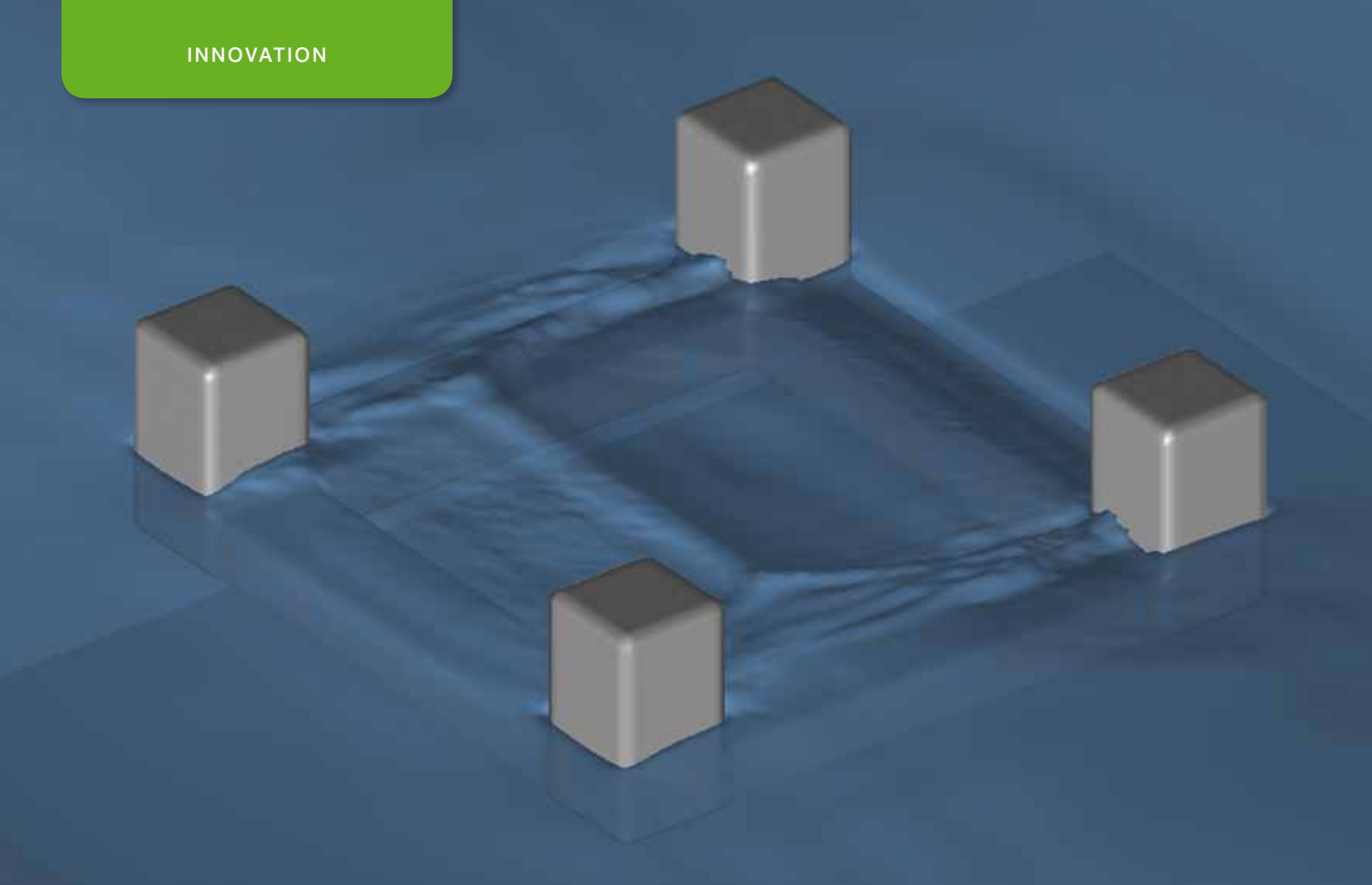


Figure 2: Comparison of the Static and Dynamic DP capability. The wind speed at which the vessel drifts off is obtained from time domain simulations. Comparison is made to the Dynamic DP capability limit obtained with a wave drift multiplier factor included.



## A Computational Fluid Dynamics study for a shallow draft semi-submersible

By Rogier de Bruijn

GustoMSC recently looked into, and exploited, the capability of Computational Fluid Dynamics (CFD) to capture the complex hydrodynamics of a shallow draft semi-submersible. The purpose was to identify the added value of using CFD in a design load assessment for a shallow draft semi-submersible. The results will be presented at the OMAE conference in Rotterdam in June 2011 [ref 1].

The hydrodynamics of a semi-submersible floating at shallow draft are strongly influenced by non-linear wave interaction with the floaters. Because conventional methods for the global strength analysis are based on linear diffraction theory, these methods have significant limitations when non-linear effects play a significant role. Since these types of problems can currently only be addressed with model testing, GustoMSC is searching for computational methods which can be used in daily engineering. With increasing computational power, CFD becomes more and more interesting for this purpose.

In this study a CFD method was used to calculate the wave loads on and internal loads of a shallow draft semi-submersible in regular waves. CFD simulations were performed using ComFLOW, a program based on the incompressible Navier-Stokes equations and the improved Volume Of Fluid (iVOF) method. The ComFLOW program is a product of the ComFLOW joint industry projects in which SBM has been involved for several years. The third ComFLOW joint industry project is still ongoing [ref 2].

When a semi-submersible is floating at shallow draft, the layer of water above the floaters can be relatively thin. Both full-scale observations and model tests have shown that in this condition the wave pattern in the vicinity of the floaters is significantly different from that corresponding to a deeper draft. Due to the limited water depth above the floaters, non-linearities in the wave pattern are introduced, even for low waves. The waves above the floaters become isolated from the surrounding sea, breaking waves are observed and when a part of the floaters emerges above the water, this induces rapid changes in water plane area.

Conventional methods for global strength analysis of semi-submersibles are generally based on linear diffraction theory, which assumes a linear relation between the wave height and the internal loads and no changes in water plane area. The non-linear effects related to the shallow layer of water above the floater make these conventional linear methods less applicable for shallow draft conditions.

For this study, CFD simulations were performed for a test case semi-submersible for which model test results were available at GustoMSC. The semi-submersible is a fictive design suitable for benign areas. As in such areas, only a small air gap is required, the unit has relatively large volume floaters and short columns. The unit consists of a ring shaped floater, four columns and a square deck box.

The calculations were performed for both deep draft and shallow draft conditions. Firstly, the wave loads acting on a fixed semi-submersible in regular waves were calculated with ComFLOW and compared with linear diffraction theory and model test results. Secondly, internal loads were calculated for a moving semi-submersible in regular waves using both ComFLOW and linear diffraction theory.

In the ComFLOW simulations, the motions of the semi-submersible were prescribed by instead of being solved by the method itself. Solving motions interactively during simulations is one of the major goals of the current ComFLOW project, but for wave application this is not yet feasible. Since internal loads were not measured during the model tests campaign, the results of the internal loads were not validated against model test results. Nonetheless, a check could be made by comparing the ComFLOW results for deep draft (where linearity is applicable) with the results of GustoMSC's dynamic loading program based on linear diffraction theory.

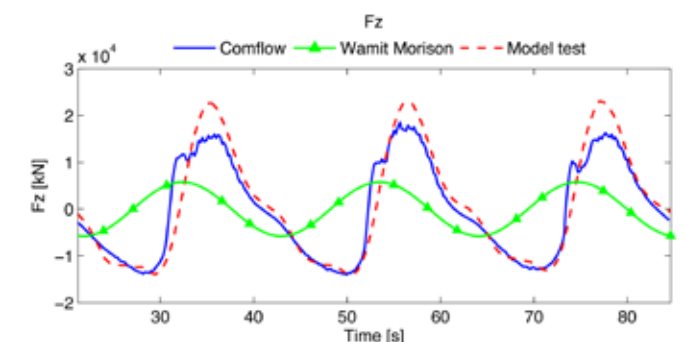


Figure 1: Vertical wave force at shallow draft

Ref 1: Rogier de Bruijn, Fons Huijs, René Huijsmans, Tim Bunnik and Marc Gerritsma - Calculation of wave forces and internal loads on a semi-submersible at shallow draft using an IVOF method - In Proceedings of the 30th Int. Conference on Ocean, Offshore and Arctic Engineering, OMAE2011, Rotterdam, The Netherlands, June 19-24, 2011, Paper OMAE 2011-49236.

Ref 2: Veldman A.E.P., Luppens R., Bunnik T., Huijsmans R.H.M., Duz B., Iwanowski B., Wemmenhove R., Borsboom M.J.A., Wellens P.R., van der Heiden H.J.L., van der Plas P. - Extreme Wave Impact on Offshore Platforms and Coastal Constructions – In Proceedings of 30th Int. Conference on Ocean, Offshore and Arctic Engineering, OMAE2011, Rotterdam, The Netherlands, June 19-24, 2011, to appear.

For shallow draft conditions, the wave loads on the fixed semi-submersible derived from the model tests are very non-linear, and significant deviations exist between the results from the diffraction program WAMIT and the model tests. The results from ComFLOW look promising. The wave loads calculated with ComFLOW largely agree with the model test results. Figures 1 and 2 show both results of the wave loads, in which ComFLOW gives much better results than the diffraction program WAMIT. The non-linearities in the wave loads are reproduced by ComFLOW with reasonable accuracy.

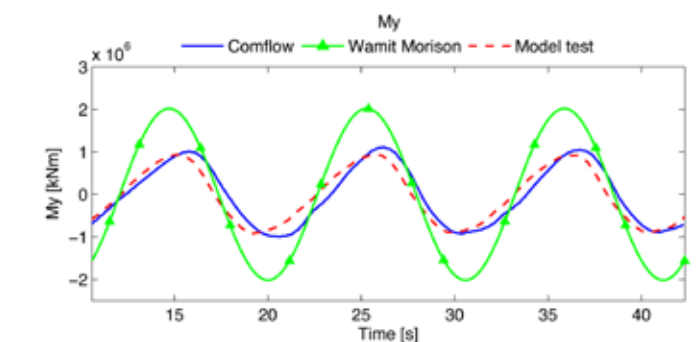


Figure 2: Wave pitch moment at shallow draft

Figure 3 shows a snapshot made during a simulation with the fixed semi-submersible at shallow draft. This picture clearly shows the non-linear wave pattern in the vicinity of the floaters of the semi-submersible which are close to the free surface. A similar wave pattern could be observed from the model tests.

The internal loads calculated with ComFLOW were quite close to the results from the linear method, even for shallow draft conditions. Since additional model testing is required for validation of these calculations, strong conclusions can not yet be drawn from these results. Moreover, the practical application of these types of calculations is still fairly limited today, due to the requirements in terms of computational power.

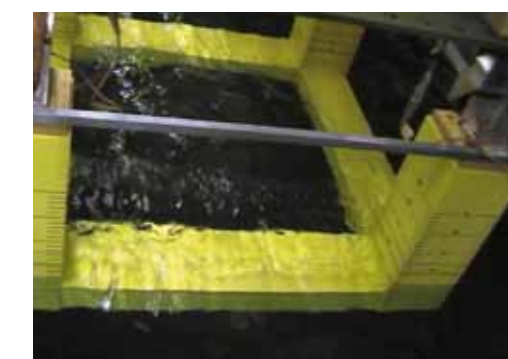


Figure 3: Snapshot of simulation with semi-submersible at shallow draft

## Recent projects

- Basic design package and supply of a package of associated equipment for two CJ70 drilling units at Keppel FELS, for Maersk Drilling
- Basic design package and supply of a package of associated equipment for “West Linus”, a CJ70 drilling unit at Jurong Shipyard, for Seadrill
- Basic design package for three GustoMSC P10,000 drillships, for Noble Corporation
- Basic design package for two GustoMSC P10,000 drillships, “Ocean BlackHawk” and “Ocean BlackHornet”, at HHI for Diamond Offshore
- Basic design package and supply of a package of associated equipment for the SEA-2500 unit “Neptune” at IHC Merwede, for GeoSea

## Recent deliveries

Unit name	GustoMSC design	Builder	Owner	Date
GMS Endeavour	NG-2500X	GMS Yard	GMS	December 2010
Alpha Star	DSS38	Keppel FELS	QGP	March 2011
Oleg Strashnov	HLV5000	IHC Merwede	SHL	March 2011

3 units to GustoMSC design delivered as of ...



## Colophon

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