



Seven Waves, a 'flex-lay' pipe laying vessel, is the latest addition to the Subsea 7 fleet. The vessel is designed and built by IHC Merwede, whilst the pipe-laying equipment and cranes were developed and installed by Huisman. It will initially be used in the Brazilian territorial waters to support the development of significant oil fields in the Santos Basin. Supporting Petrobras during a five-year contract, the 'flex-lay' vessel will mainly be installing flexible flow lines and risers in water depths up to 2,500 metres, off the coast of Brazil.

Seven Waves, the fifth vessel contracted by Subsea 7 to IHC Merwede's Offshore division, will mark the next chapter in Subsea's Brazilian operations as the first of a new generation of high tension pipe layers contracted to Petrobras. *Seven Waves* was preceded by the delivery of *Seven Oceans* (pipe laying), *Seven Seas* (pipe laying and construction), *Seven Atlantic* (diving support) and *Seven Pacific* (pipe laying). Subsea 7 selected IHC Merwede and Huisman for this latest vessel, primarily for their efficiency and reliability in delivering the four previous orders on time, whilst at the same time meeting the required level of quality.

With the contract between the Subsea 7 and IHC Merwede signed in November 2011, the keel-laying ceremony was held one month

ahead of schedule in August 2012. The naming ceremony was performed on 3 May 2013 by Lucia Andrade, the ship's godmother. Although originally planned at the end of the first quarter of 2014, the vessel was delivered in two weeks early in March 2014.

The synergy, concept studies and basic design IHC Offshore & Marine designed the ship in close cooperation with Subsea 7. The overall construction and all associated shipbuilding aspects were handled by the IHC Merwede yard in Krimpen aan den IJssel, while the development of the ship's cranes, pipe handling plant and pipe lay tower was done by Huisman Equipment. For installation of all Huisman equipment, the vessel was sailed to their local facilities in Schiedam, the Netherlands.

SEVEN WAVES

EVERY SEVENTH WAVE IS HIGHER

Builder

IHC Merwede BV, Krimpen aan den IJssel, The Netherlands

Owner

Subsea7, London, United Kingdom

Principal particulars

Length o.a.	145.90 m
Beam mld.	29.90 m
Depth to main deck	13.00 m
Draught, operational	7.20 m
Draught, max.	8.30 m
Air draught, ramp upright	66.90 m (at T = 6.60 m)
Air draught, ramp inclined	47.40 m (at T = 6.60 m)
Speed, service	13.8 kn

Cargo capacities

Deadweight, operational	7,025 t
Deadweight, max.	11,312 t
Displacement, max.	27,012 t
Gross Tonnage	17,283
Net Tonnage	5,185

Complement

Single berth cabins/dayroom	4 x 1 person
Single berth cabins	40 x 1 person
Double berth cabins	38 x 2 persons
Crew, total	120 persons
Hospital capacity (excl.)	3 persons

Tank capacities

Marine Gas Oil	2,197 m ³
Fresh water	998 m ³
Ballast water	4,696 m ³
Anti-heel ballast water	1,525 m ³
Technical fresh water	633 m ³



The helicopter deck, on deck ten forward of the superstructure, is an approved and certified platform

Whilst developing deepwater oil resources is becoming increasingly economically viable, this has implications for the design of the vessel with respect to their ability to stay at sea for longer periods. The Santos Basin is such a remote deepwater project and to fulfil the project requirements, the vessel is equipped for transporting and installing flexible flow lines and umbilicals in water depths of up to 2,500 metres. The vessel is designed to operate fully autonomously, with all facilities on board for loading and laying flexible pipes.

The vessel itself is a DP2 mono-hull, built to Lloyd's Class requirements, with an overall length of 146 metres. The beam of 30 metres is determined as a result of the stability and port access requirements. Considering the

effect the amount of deck equipment has on the vessel centre of gravity, meeting the stability requirements whilst also having a width restriction was a challenge. The vessel is equipped with a vertical lay system, a mast crane, a knuckle-boom crane and twin ROV systems. The hull features two under-deck storage carousels for flexible pipe and a moonpool.

Accommodation and wheelhouse

The superstructure of the *Seven Waves* is

located forward and has accommodation for 120 persons in four single berth 'staterooms' with separate day-room, 40 single berth cabins and 38 double berth cabins. To facilitate the required hospital capacity another three berths are provided in a separate 'sick bay'. In addition to the necessary staircases, the superstructure features an elevator, running from deck four up to deck ten, with the shaft extended into deck three to house the dedicated machinery and equipment. This technically advanced ship will also exploit IHC Merwede's

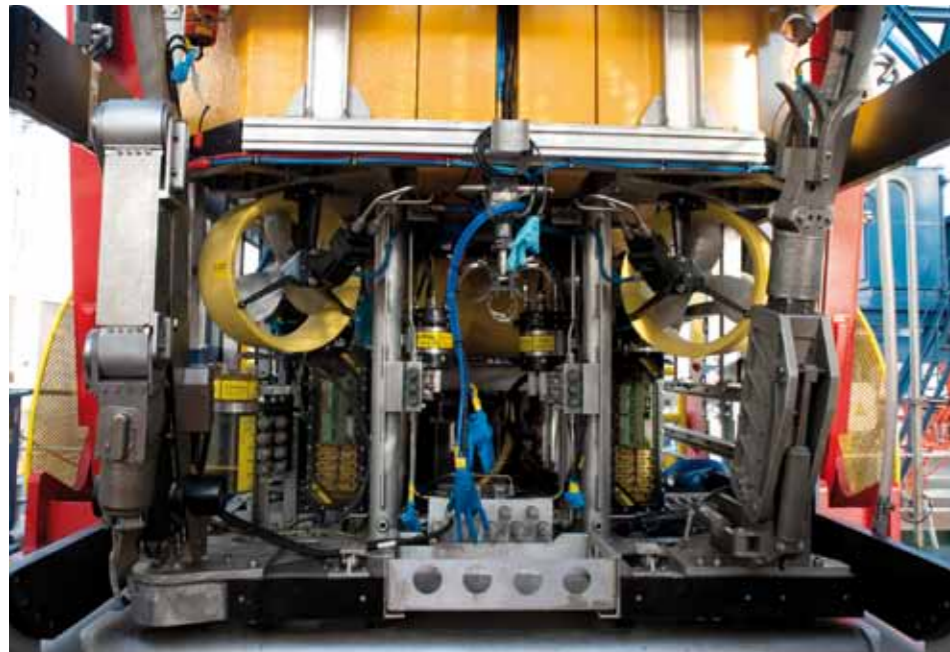
"A new generation of high tension pipe layers"



The second largest crane on board is a knuckle boom, which is on starboard side behind the carousels



The largest TLS ever produced at Huisman, seen from Helicopter deck, behind the mast with communication equipment



One of the two over the side launched 'work class' ROVs, complete with their own launch and recovery systems

knowledge and experience in offshore dredging vessels, to provide a comfortable and quiet accommodation. These include low noise and vibration levels and further features to provide the personnel with a high level of comfort.

Deck ten is the helicopter deck and has the helicopter reception area with adjoining changing room and on starboard side an air-conditioning room. The helideck itself is an approved and certified platform, suitable for Sikorsky S92 and Super Puma operations.

Deck nine is the wheelhouse deck with two effective bridges: the forward facing part, used solely for transit sailing and the aft facing area, where the DP can be controlled during pipe laying and lifting activities. Between the two bridge parts are the safety centre, captain's office, sanitary and pantry facilities. The wheelhouse (and engine control room, as well as the rest of the vessel) features an impressive level of intelligent automation. The monitoring and control systems are mainly touchscreens, allowing the users intuitive, rapid and accurate (inter)actions by means of simple touch gestures.

The first crew and client accommodation are found on deck eight, offering facilities for 28 persons in 22 cabins. Furthermore this deck contains offices, a conference room, an electronic equipment room, an AC room, storage spaces, a survey room and an operations room. These survey and operations areas are dedicated to control and monitor all survey, pipe laying and lifting activities. One level lower, deck seven, accommodates 48 persons in 35 cabins, various smaller storages and luggage rooms, a large storage room on portside aft and the emergency/harbour generator on starboard side aft.

*"Autonomously
developing remote
deepwater
energy resources"*

*"One of the Netherlands' largest
ever produced tilttable lay system"*

On both sides of the open deck of level six, the lifeboats and life rafts are to be found, each with dedicated davit installations and cranes. Inside we find the sick bay on starboard side, comprising of a treatment room, the hospital ward and the medic's office. The remaining space is used for accommodating 25 crew cabins for 44 persons.

Part of deck five is dedicated to the davit installations of the lifeboats, on portside complemented by the m.o.b. boat, which are all outside. Inside this deck, all facilities for the well-being and relaxation of all personnel on board are to be found. These facilities comprise of a lounge/video room, internet lounge, smoking lounge, library and fitness room. On the starboard side forward are the linen store and laundry. The work areas on this deck are primarily dedicated to the ROV, with its control room, spare part storage and electrical, hydraulics and mechanical workshop. Other remaining spaces are filled with various AC units.

Deck four, which is the main deck, is the busiest level in the vessel it is here that all personnel embark and disembark or go through to the outside work areas. Besides a conference room, the various staff offices, the security office/reception and changing rooms, this fourth deck accommodates the mess room, galley including bakery and all catering related spaces, like cold and freeze storage rooms, dry provision stores and garbage disposal equipment.

All decks below the fourth deck are filled with technical spaces. Here we find, amongst others, the engine rooms, separator rooms, bow thruster rooms (four in number), the engine control room, switch board rooms, workshops and storages for various machine/engine parts and equipment. The fore peak, as well as housing the anchor equipment and chain lockers, is also reserved for a boatswain's store and a paint store.

Propulsion and power

The ship's power is generated by two times three 3,840 kW (4,100 kVA) diesel generator sets, through two main switchboards, as is required by the DP2 notation in separate watertight compartments. The generator sets themselves are located in two full width engine rooms, one in front of the other. The vessel also has



The most notable features of the flex-lay system is its vertical ramp which is kept upright by two adjustable struts to the deck

an emergency/harbour generator set installed above main deck.

Main propulsion is provided by three fixed pitch/variable speed azimuthing propulsors of 2,950 kW rating that can be demounted underwater without dry-docking the vessel. For DP (on site) operations and harbour manoeuvring two 2,400 kW retractable azimuthing thrusters and two 2,200 kW tunnel thrusters are provided in the bow.

All propellers are treated with a silicone coating to provide an ultra-smooth and slippery surface. This surface treatment means fouling organisms are unable to attach or have difficulty settling onto the surface. This is one of the provisions allowing extended dry-docking intervals.

The electrical installation comprises of an energy system with a high level of redundancy, featuring a low and high voltage (22 MW) installation. These systems are fed and controlled by direct water-cooled compact frequency drives. Bakker Slidrecht, in close co-operation with Croon, supplied the engineering, manufacturing and installation of the complete electrical installation, both high and low voltage.

Cranage and material loading

One of the major requirements for this type of vessel, to be able to operate fully autonomously, is on-board hoisting capacity. For this, a large Huisman mast crane of 400 tons lift capacity at an outreach of 16.5 metres and a wire length of 2,500 metres is placed on portside in between the underdeck storage carousels. At its maximum outreach of 39.5 metres, the crane's lifting capacity is reduced to 132 tons using a single fall.

The second largest crane is a knuckle boom type of 25 tons at an outreach of 15 metres

The ship's power is generated by two times three 3,840 kW (4,100 kVA) diesel generator sets



The core diameter of the carousels can be increased by means of placing a so called 'false core' (a cage like structure)

and a maximum outreach of 32 metres, which is on starboard side behind the carousels. The third crane, on the lay tower, is a bit smaller and offers 25 tons at an outreach of ten metres and a maximum outreach of 15 metres. The last two, relatively small, knuckle booms are to be found near the moon pool and tower storages. These two are able to lift five tons at a maximum outreach of 17 metres.

For all loading and unloading operations to be conducted at sea, the large mast crane and its smaller partner the knuckle boom crane are heave compensated. For bringing material on board at water level over the stern, the vessel's transom is provided with retractable chutes.

Flex Laying

For this Subsea 7 vessel, Huisman Equipment

designed and delivered the complete flex-lay system, except for the baskets/carousels in the hold. The most notable features of this system is its vertical ramp (or tower), equipped with two tensioners and an aligner wheel on top. The ramp is kept upright by two adjustable struts to the deck. The flexible pipe is spooled from one of the horizontal carousels (or baskets), then curves over the top wheel and guided through the tensioners down into the water and onto the seabed. This TLS (Tiltable Lay System) is the largest ever produced at the Schiedam facilities of Huisman. Specifically for testing such large equipment, the company built a production hall of 60 metres high in which the tower was not only completely built, but also partially tested. The full system was transported to the vessel over reinforced skid pads between the production hall and the quay side.

Seven Waves is fitted with two underdeck storage carousels, of which the forward has a capacity of 2,500 tons and the aft one of 1,500 tons of flexible pipe. The carousels are driven by electrical motors via a gearbox and a rack and pinion drive. A spooling device (or pipe guide) is part of the system and all (carousel) system components are synchronised with each other, as well as with the above deck tensioners. As icing on the cake, the core diameter of the carousels can be increased by means of placing a

*" Five down, two to go:
more Flex-Lay vessels to
be built simultaneously"*



The electrical installation comprises of an energy system with 6 board net transformers, feeding a low and high voltage installation

so called 'false core' (a cage like structure). Thus, when using smaller diameters pipe or when less pipe length is required, only the outer portion of the carousel is filled. This results in higher unloading speed during the laying process.

The vertical ramp or lay tower, with a total top tension capacity of 550 tons, is permanently installed on deck for deployment of a range of flexible pipe products with a diameter from 100 to 630 millimetres. The lay tower can be tilted and operate at an angle up to ten degrees from vertical, to accommodate laying in shallow water, thus increasing the pipe radius and reducing stress/fatigue.

Two tensioners are fitted on the tower to keep tension in the pipeline, while it is being lowered onto the seabed. The tensioner control system monitors the outboard pipe tension and paid out length as part of the lay process, whilst at the same time giving feedback to the lay speed setting coupled to the vessel's DP system. The tensioners on board *Seven Waves* each have a capacity of 275 tons, are fitted with wire centralisers and can be retracted clear of the firing line. For obtaining an air draught of 48 metres, the complete ramp assembly can be tilted even further to an angle of 49 degrees from vertical. This is done when the vessel is in transit mode (unable to lay pipes) an allows it to pass under restricted height bridges and other structures.

To connect pipe sections, pipe line end terminations (PLETs) are used which are stored in a dedicated space on deck. To transport these PLETs from their storage position to the ramp, a fully automated handling system is installed. Once a PLET is loaded and in place, the handling system lifts it up to align with the tower. The tower stands over a moon pool in

which the previously installed pipe section is retained on a hang-off clamp. In addition to this collar hang-off clamp, which integrated in the work over hatches, an additional friction clamp can be installed below the work over hatches.

Hang-off clamps are used to hold the pipe when it is not suspended by other means such as tensioners. The hang-off clamp supports the pipe by means of friction, using pressure cylinders to generate the holding power. The moonpool of *Seven Waves* is designed to hang off pipe assemblies up to 600 tons and is also fitted with a mechanism to allow this assembly to be rotated under full load. When not in use, the moonpool can be closed by means of bottom doors, controlled and monitored by a system developed by IHC Offshore Systems, part of IHC Merwede.

The power is distributed through two main switchboard rooms with low and high voltage circuits



Should a situation arise like a weather change, such that operations have to stop and the ship has to abandon the site, the pipe end is terminated, lowered to the seabed and released. Once back on site, the end of the pipe is recovered and manipulated back into the moonpool. For this, *Seven Waves* is equipped with an A&R (Abandon & Recovery) system, featuring two winches of 600 tons and 200 tons, with 3,500 and 2,000 metres of wire respectively.

ROVs

Seven Waves is equipped with two over the side launched 'work class' remotely operated vehicles (ROVs), complete with their own launch and recovery systems. They are located just aft of the superstructure one either side of the vessel on main deck. The ROVs are capable of working to depths of 3,000 metres.

Conclusion

With this vessel another chapter is marked in the evolution of high tension pipe layers. To achieve this, they have a very intense collaboration between their own divisions and sister companies, as well as with a limited, but select group of co-manufacturers/sub-contractors. Such developments and the advanced levels of automation, were also made possible due to a good interaction with and support from Lloyd's Classification Society.

With *Seven Waves*, Subsea 7 will have another valuable tool to assist with their ever more demanding projects. It would seem that their toolbox is not full yet, as in the same week of delivery of this vessel, IHC Merwede performed the keel laying ceremony of yet two (YN 731 & 733) more flex-lay vessels to be built simultaneously at the IHC Merwede shipyards in Kinderdijk and Krimpen aan den IJssel.

Tom Oomkens