Insight

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Gems of the offshore industry

Cost-effective TSHDs now built for stock

Introducing an award-winning subsea trencher

Adding value with innovative training simulators

The technology innovator.

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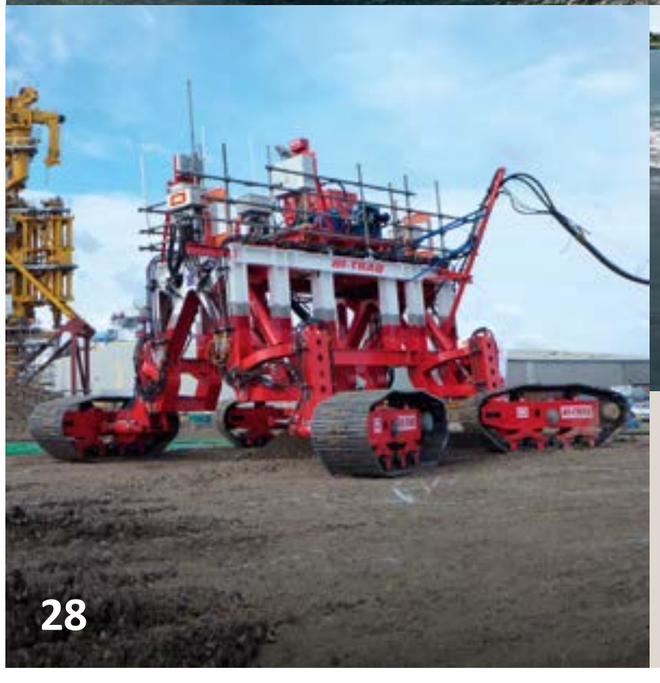

Welcome

Dear reader,

In this issue of *IHC Insight* you will find a broad cross-section of interesting information with the most recent news, deliveries and experiences of Royal IHC's (IHC) advanced equipment and innovative vessels.

IHC has successfully built a number of 550t flex pipelaying vessels for several customers. The lead article highlights two of these ships that have been delivered to Sapura Navegação Marítima, which is already appreciative of IHC's unique approach. They are the first vessels of their kind with a fully integrated IHC design and construction, and thus providing relatively high availability.

Some of IHC's recent equipment deliveries have been accompanied by training programmes and training simulators. Among them are simulators for the flex pipelaying vessels mentioned above and the cutter suction dredger (CSD) for Huta Marine Works (see below). These versatile and innovative pieces of equipment are detailed on pages 16-21.

Huta Marine Works recently commissioned its self-propelled CSD AL BAHAR. This complete dredger and her main systems and features are the subject of the fourth feature, with especially beautiful pictures of her launch and maiden voyage.

After a thorough investigation of the costs and risks accompanying shallow water cablelaying for wind farms, IHC Engineering Business has come up with an inventive tool that promises greater efficiency by counteracting all of the restricting factors in this sector – this is presented on pages 28-33.

The final article demonstrates IHC's willingness – as the technology innovator – to also create new solutions in the field of dredging economics. The construction of an Easydredge® 2700 TSHD for stock cuts across the vicious financial and contractual circle with which entrants to the dredging market are confronted. Not simply building a vessel, but also solving an economic problem – that is the innovation, materialised in this bold step.

Enjoy reading!

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IHC Merwede has become Royal IHC

His Majesty the King has awarded the honorary title of *Koninklijk* (Royal) to IHC Merwede. In a special ceremony today, the Mayor of Sliedrecht, Mr van Hemmen, presented this accolade to IHC's CEO, Bram Roelse. In light of this honour, the company has decided to change its name to Royal IHC and will also include the royal crown in its revised corporate identity.

Royal title
The Royal title is an award granted to companies or organisations that meet certain conditions. To qualify, the nominated company must have been in existence for at least 100 years and should have prestige with regard to its image, size and reliability. It must be of national importance to and have prominence in The Netherlands – preferably with an international outlook – and the size of the company, the number of employees and its annual turnover are also taken into account.

History
In 2013, IHC had been in existence for 325 years. The predecessors of the Kinderdijk shipyards, L Smit & Zoon and J & K Smit, were already active in the 17th Century, while the other four IHC shipyards were involved from the late 19th Century (Gusto in Schiedam and Conrad in Haarlem) or the beginning of the 20th Century (Verschure in Amsterdam and De Klop in Sliedrecht).

Finally, in 1943 the six shipyards – specialising in the construction of dredging equipment and tin mills – decided to a form of collaboration, Industrieele Handels Combinatie (IHC) Holland. Nowadays, IHC is renowned as the world's leading supplier of efficient vessels and equipment for the dredging and wet mining markets, and recognised as a reliable supplier of innovative ships and supplies for offshore construction.

Twin exposition
The presentation of the Royal title took place at the grand opening of IHC's exposition at the National Dredging Museum in Sliedrecht, which – together with an exposition about the company in the Maritime Museum Rotterdam – ran until 23 November this year.

The Sliedrecht exhibition (IHC Merwede: yards with a reputation) focused primarily on the six shipyards, their products and people.

The Rotterdam display (Hi-tec Dutch maritime) highlighted the innovative contribution that IHC has made towards the welfare of man and society over the decades. This was shown by the impact of the company on key social developments, such as population growth, increasing world trade, growing energy consumption and the spiralling demand for minerals.

New name and logo
Bram Roelse, CEO of IHC, said: "Obviously we are extremely proud of receiving this distinguished title – so much so that we have decided to change our company name to Royal IHC and add the royal crown to our revised logo. In this way, we have reverted the name back to the roots of our wonderful company, which now has more than 3,000 employees.

"Merwede was added to IHC in 2005 after the merger between the two companies, but we feel that the new name matches the current need for projecting one company to the outside world and is also easier to pronounce on an international basis. The title and name symbolise the character of this company, in which keywords such as internationalisation, innovation, pride, passion and dedication have played a very important role over the centuries."

IHC building Easydredge® 2700 for stock

IHC is constructing the first vessel in its range of competitively priced standard trailing suction hopper dredgers (TSHD). It has started to build the Easydredge® 2700 for stock in response to the increasing global demand for TSHDs with an extremely short delivery time.

The new vessel will be supplied with a "world-dredging package", which includes bottom doors, a bow coupling and a dredging depth of 25m. This makes her suitable for a wide range of tasks, from the maintenance of ports and channels, to land reclamation.

Fer Tummers, Managing Director of IHC's Dredging Division, said: "Building a TSHD for stock is a logical step forward for IHC. We are convinced that this is also an excellent opportunity for our customers operating worldwide. Availability of dredging equipment often causes a bottleneck for new entrants to this market. The need to have equipment to secure a contract, and the need for a contract to secure financing to procure this equipment is a vicious circle that IHC aims to help break by having new equipment available from stock.

"In addition, we have experienced that standardisation, combined with extremely short delivery times, is a highly successful concept for our range of IHC Beaver® cutter suction

dredgers. This enables us to achieve the combination of a high-quality product at a relatively low level of investment – and we are convinced that this also applies to the standard TSHD series."

The construction of the Easydredge® 2700 is being carried out by IHC partner MTG Dolphin's shipyard in Varna, Bulgaria. It is responsible for the assembly process and will deliver the vessel in summer 2015.

For more information, please visit www.easydredge.com

IHC launches innovative Hi-Traq trencher

IHC has officially introduced the world's first four-tracked subsea trencher, specifically developed for shallow water operations and targeted towards cable burial in offshore wind farms. The Hi-Traq was presented at a special event at the Stadium of Light in Sunderland, which was attended by offshore wind industry professionals from the UK, Europe and the USA.

This new remotely operated vehicle has been developed to be the most efficient tracked trencher, capable of tackling the full range of challenges typically faced in this application. High wave loadings and strong currents at the seabed meant the vehicle had to have a minimum weight to guarantee safe, accurate working and efficient trenching operations, for example. Varied seabed soil conditions were also considered in the Hi-Traq's design.

Will Stephenson, Sales Engineer at IHC Engineering Business explained how the Hi-Traq differed from existing trenching assets: "Features such as the independent four-track undercarriage and a flexible tooling arrangement were engineered as integral parts of the design, and have remained the main focus of the project throughout."
A high level of manoeuvrability also sets the Hi-Traq apart from the competition. The four-track undercarriage design enables it to climb slopes with gradients of up to 20 degrees. This high traction functionality gives the vehicle its name.

Hi-Traq has been successfully tested and demonstrated at IHC's the Port of Tyne facility in South Shields, where a special terrain was created to mimic subsea conditions. "The test programme has confirmed that the Hi-Traq trencher is capable of fulfilling all of our functional requirements," said Will.

IHC Hytech wins order for containerised air-dive spreads

IHC Hytech has secured an order for two innovative containerised air-dive spreads from Bluestream, an offshore and subsea company that operates in the oil and gas, and renewable energy sectors. These high-quality systems consist of a containerised 1,800mm decompression chamber with a full three-dive control panel and a separate machinery container that will be modified to meet the customer's needs.

The complete containerised air dive spread has been certified by Lloyd's Register, as part of the increasingly stringent regulations addressed by IHC Hytech that are particularly relevant to all parties involved in the surface-supplied diving industry.

IHC Hytech will supply the chambers in 20ft containers and the dive control panel with the latest available technologies in dive monitoring and layout design. For example, it will be computerised with a remote readout and complete sensor package. The divers' data acquisition system will be installed in a 19" rack with (among other features) two radios, inline breathing gas supply, oxygen percentage monitoring, video systems and various alarm units.

The divers' data monitoring system is state of the art for the offshore diving sector, enhancing the safety and efficiency of shallow water diving operations. It displays and records vital data, including diver and chamber depth against time, and the dive control is installed with the latest camera and light control units for optimised subsea images.

The advanced equipment in the container also includes an inline air purity monitoring system with a multi-sensor gas analyser. This is specifically designed for the analysis of contaminants in compressed breathing air and offers an online analysis facility. This is complemented by the monitoring of the breathing gas compressor inlet for optimum safety.

"We are delighted that we will be manufacturing these high-end containerised air-dive spreads for Bluestream, which has been a valued customer of IHC Hytech for many years," said IHC Hytech's Managing Director Johan de Bie. "We are aware of our customers' need to comply with legislation, and as an authority in this area of the subsea business, we can advise on the best and safest solutions to meet their specific requirements."

IHC sells subsidiary IHC Sealing Solutions

IHC, the global leader in shipbuilding for the dredging and offshore industries, has reached an agreement to sell 100% of its shares in its subsidiary IHC Sealing Solutions. The new owners are Willem Steenge, who as CEO is partly responsible for the strong growth of IHC Sealing Solutions in recent years, and Rabo Participaties (RaPar).

IHC: focusing on core activities
The sale enables IHC to strengthen its focus on its core business: offering integrated innovative vessels, advanced equipment and life-cycle support to the dredging, wet mining and offshore construction industries.

Bram Roelse, CEO of IHC, said: "IHC Sealing Solutions is a very stable and healthy company that deals with great projects and strong patents. However, its activities are not directly related to IHC's business strategy. IHC Sealing Solutions has been operating independently since 1979 and its target markets are mostly external to IHC's activities."

IHC Sealing Solutions: further growth and development
IHC Sealing Solutions is continuing under the leadership of CEO Willem Steenge, who in the past 14 years has guaranteed strong growth and development for the company. With RaPar and Rabobank as financial partners, a dedicated team has been assembled to serve the market with services that focus on quality, commitment and reliability.

"On behalf of the management of IHC Sealing Solutions, I can confirm that we are very pleased with this acquisition," said Willem. "Together with our colleagues, and supported by RaPar and Rabobank, we have a positive outlook for the future. We will make every effort to continue and improve the service and growth of the company in recent years.

Rabo Participaties: a successfully expanding portfolio
Rabo Participaties is one of the private equity funds of the Rabobank Group, which supports growing Dutch companies through minority interests. With the successful completion of this transaction, its portfolio has expanded to 11 companies in various sectors.

Bob van der Veen, Director of RaPar, commented: "We are delighted with this transaction. We have been impressed by the experienced management team, led by CEO Willem Steenge, which has helped the company to develop and grow in recent years. IHC Sealing Solutions is a strong brand and, thanks to recent investment in the new plant in Alblasserdam, it will continue to provide high-quality innovative products within strict timelines."

IHC holds naming ceremony for ITALENI

The South African company Transnet National Ports Authority (TNPA) has named its 750m^3 grab hopper dredger, ITALENI, during a special ceremony hosted by the shipbuilder IHC. The ceremony was performed on 18 June by TNPA's Supply Chain General Manager, Ms Ncumisa Nkanunu, in the shipyard of IHC's partner, MTG Dolphin, in Varna, Bulgaria.

The contract for the design, construction and delivery of the grab hopper dredger was signed between TNPA and IHC Global Production on 29 January 2013. The keel was laid on 20 August 2013 and the vessel will sail under her own keel to Durban, South Africa later this month.

The ITALENI has been designed and built to achieve low maintenance costs. The vessel will replace the current grab hopper dredger, CRANE, which has recently been equipped with a new grab crane. This equipment will be transferred to the ITALENI after her arrival in South Africa. The ITALENI will be used mainly for maintenance work in various ports throughout the country.

The dredger is named after the battle of Italeni that took place near the Itala Mountains, where the Zulu King Dingane defeated the Voortrekkers in 1838.

Tau Morwe, TNPA's Chief Executive, said: "The new dredger will ensure that we have the capacity to meet demand in line with our strategic objectives, as well as providing spare dredging capacity that we can sell on to neighbouring ports."

Fer Tummers, Managing Director of IHC's Dredging Division, said: "The ITALENI is not the first vessel that IHC has built for TNPA. IHC has already proven itself to be a reliable and professional partner with the successful delivery of the trailing suction hopper dredger [TSHD] ISANDLWANA in 2010.

"We are also proud to be building a third vessel for TNPA, a 5,500m^3 TSHD. This will be the largest vessel of its kind to operate in South Africa and a sign of our continuing successful cooperation.

"As part of our ongoing commitment to TNPA, IHC is glad to be participating in economic developments in South Africa by implementing a Supplier Development Plan to help improve local industry. This initiative will include the transfer of some of our knowledge and advanced technology to enhance the skills of the workforce within the region."

IHC secures order for 5,500m^3 TSHD from TNPA

IHC has been awarded the contract for the design, construction and delivery of a 5,500m^3 trailing suction hopper dredger (TSHD) to Transnet National Ports Authority (TNPA) in South Africa. The company was selected after a successful submission into an open tender process for what will be the largest dredging vessel of its kind operating in the country.

The new TSHD will join TNPA's existing fleet of IHC-built vessels, which features: the 4,200m^3 TSHD ISANDLWANA (ordered in 2008); and the grab hopper dredger ITALENI (ordered in 2013).

As one of the five operating divisions of Transnet SOC Ltd., TNPA is responsible for the safe, effective and efficient economic functioning of the South African national port system. It manages eight commercial ports along the country's 2,954km coastline in a landlord capacity, with two main service categories: the provision of port infrastructure; and the provision of maritime services, such as dredging and marine operations. As part of its contract with TNPA, IHC will execute a social development plan in order to help improve local industry in South Africa. This initiative will feature the appropriate transfer of some of the company's advanced technology and knowledge base to aid the development of the workforce's skills within the region.

Five jewels for the offshore industry:

Royal IHC builds integrated PLVs for Sapura Navegação Marítima

1. The SAPURA DIAMANTE during sea trials. Note the large free aft deck area.

In recent years, Royal IHC (IHC) has built a variety of bespoke and integrated offshore vessels, including rigid pipelay [1] and flex pipelay vessels, for example the SEVEN SEAS and the SEVEN PACIFIC [2]. This set a precedent, so when Petrobras, the Brazilian energy giant, planned to expand exploitation in pre-salt areas in Brazilian waters and the Gulf of Mexico, IHC was a logical choice. The plans required a host of offshore construction and pipelay vessels to be chartered for providing the subsea piping, necessary to bring the oil to FPSOs and onshore. To serve this need, IHC's loyal customer, Subsea 7, ordered three identical flex pipelay vessels, and a new client also knocked on the door: Sapura Navegação Marítima.

2. The SAPURA TOPÁZIO. The pipelay tower is elevated with cylinders, the support of which is incorporated in the deckhouse strength structure

3. On the launch day of the SAPURA DIAMANTE, a large part of the SAPURA TOPÁZIO was already on the upper slipway

In January 2012 IHC Offshore & Marine and Sapura Navegação Marítima signed contracts for the design, engineering and construction of two new 550t pipelaying vessels, and a third contract for the design, engineering and delivery of vital equipment for local building of a 300t pipelaying vessel. In August 2013 these contracts were followed by an order for three additional fully integrated 550t pipelaying vessels.

Including the existing order for the SEVEN WAVES, just under construction at the time, no fewer than 10 IHC offshore construction vessels would be sailing in Brazil between 2014 and 2016.

The first two of the 550t vessels for Sapura Navegação Marítima, the SAPURA DIAMANTE and the SAPURA TOPÁZIO, are already operational (*figures 1-2*). To briefly characterise these DP2 vessels, they are equipped with a twin-tensioner tilting lay tower and two below-deck baskets for 2,500/1,500 tonnes of product with diameters of 100-630mm. Support equipment for the loading, spooling and routing of product completes the mission equipment.

The making of…

What seemed business as usual, although at an unprecedented scale, was not the case in reality. Previously, IHC had relied on third parties for mission equipment and control systems; integration of which is a complex task in itself. The vessels for Sapura Navegação Marítima represented a new challenge: they would be equipped with a flex-lay tower, and an electrical and automation system, supplied entirely by IHC. This involved large-scale teamwork by several IHC units in the areas of technology, planning and logistics, with positive results. Barely three years after the signing of the contract, three vessels (one for Subsea 7, two for Sapura Navegação Marítima) are now operational and performing well.

This integrated approach is beneficial to customers. In every stage of the technical assessment and building process they deal with one organisation that offers a comprehensive solution for every need. For example, IHC assisted Sapura Navegação Marítima with the technical qualification and financing arrangements. On-board familiarisation of the crew is also easier with a single contact. The spare parts package can be comprehensive. Finally, Sapura Navegação Marítima may count on a single party for helping it to assist its client: IHC recently established a regional support office in Brazil for the provision of quick technical and operational support for the 10 – and possibly more – IHC vessels that will work there.

Another advantage is that the operational input of the customer in the building process needs to be expressed only once and then is processed by the whole project organisation immediately, without contractual or commercial barriers and/or IP protection problems. In this way the vessels described in this article have become ‘extensions’ of Sapura Navegação Marítima’s team – *their* best equipped operational tool with guaranteed IHC quality.
From a technical point of view, the building process considerably benefitted from the integrated approach. For example, the same fatigue calculation procedure served for the lay tower and its interface on the ship. It enabled the tower dimensions and the vessel reinforcement constructions to be synchronised with each other, delivering the optimal design for both without compromise and within a short timeframe. Many other aspects of the mutual tuning of vessel and mission equipment were developed in the same manner.

The agreed delivery times with the customer and the short intervals between vessel deliveries have resulted in the setup of a very tight schedule. At the launch of one vessel, the largest possible part of the next was already on the upper part of the slipway (*figure 3*). After launch, this second vessel was transported down for further completion. Simultaneously the third vessel’s construction started on the upper part of the slipway, ready for transport on the second vessel’s launch day. In the meantime the first vessel was being commissioned. Thanks to all the effort of those involved, IHC has delivered three ships within three years after signing the contract. By comparison, the first vessel to be supplied by the competition (which also received orders for several vessels), will arrive later than the first three IHC vessels.

In order to provide more flexibility in the delivery schedule for the mitigation of any unexpected issues concerning automation, the sea trials were brought forward by two weeks. This placed a greater urgency on the mission equipment commissioning and delivery. The 12-day sea trials included the IMO and nautical trials, pipelay trials (*figure 4*), DP trials, FMEA tests and blackout tests. Everything went well. The SAPURA DIAMANTE was handed over to the owner before the contractual delivery date. The SAPURA TOPÁZIO followed at the end of August 2014.

The platform

In operational terms, the vessel as such is usually called the ‘platform’, while the equipment that is needed to do the job outside of the ship is named the ‘mission equipment’.

The SAPURA DIAMANTE and SAPURA TOPÁZIO are DP2 offshore construction vessels, designed for flexible pipelay, umbilical lay, cablelay, recovery of pipeline, general subsea construction and ROV operations (*figure 5*). The simplest definition of the DP2 class is that a single failure in any active component or system will not lead to the loss of position. This has consequences for the general arrangement, the propulsion, the electrical installation and the DP system itself, which all have to encompass a sufficient level of redundancy. For example, in order to maintain adequate position-keeping capability after failure, two tunnel transverse thrusters and two separate autonomous engine rooms have been installed, as well as two main switchboards. In addition, in both vessels preparations have been made for DP class 3, which prescribes that flooding or fire in an entire section might not lead to loss of position. Such measures, for example, require several systems to compartmentalised.

The vessels are diesel-electric driven. Two engine rooms in the foreship, each with three generator sets of 4,100kVA and independent auxiliaries, power the entire platform and mission equipment. An automatically starting harbour/emergency generator is added to the grid. The vessel’s propulsion has been arranged with three electrically driven 2,950kW azimuth thrusters with fixed pitch propellers in a nozzle in the aft ship. These are supported by two ditto 2,400kW retractable azimuth


4. Pipelaying was included in the sea trials


5. The vessels are suitable to perform ROV operations


6. The design with the tower positioned before the moonpool results in a large free aft deck space


7. The pipelay tower was lifted on board as a whole

thrusters in the forward part of the vessel and two 2,200kW transverse thrusters in the foreship, for DP and manoeuvring operations. Propelled by this arrangement, the Petrobras assessment criteria for DP capability are fully matched.

Physically the platform, which has been optimised for energy consumption, comprises the following parts (above deck from bow to stern): the helicopter deck, accommodation and bridge, immediately followed by the flex-lay tower, the worktable above the moonpool, concluded with a large free aft deck area (*figure 6*) on which main and auxiliary cranes are positioned as well as the pipe loading/unloading tensioners and tugger winches. In the same order, below deck we find the forepeak, retractable and transverse thruster rooms, the engine rooms fore and aft, moonpool, A&R storage winch rooms, two basket rooms and finally the three thruster rooms in the stern.

The 10 x 7.50 metre moonpool is of a design nearly identical to that, used earlier in the SEVEN SEAS [2]. Apart from its worktable with friction hang-off clamp of 610 tonnes, it has been equipped with a grid-shaped hinged bottom door with a free water entrance of 70 per cent and open cofferdams to provide damping of the water and an improved hydromechanical profile during sailing. An anti-heeling system limits static heel at approximately zero at differing main crane load and outreach, and is in cooperation with the ballast system utilised for pre-heeling prior to heavy lift operations.

The mission equipment

The major component of the vertical 550t lay system (VLS) designed by IHC Engineering Business (IHC EB) is the flexible pipelay tower, installed directly aft of the accommodation and over the moonpool. Its synchronised tilting cylinders, supported in the accommodation superstructure, can move it between 80-90 degrees. The arrangement allows for a large worktable to perform activities to pipes and pipe ends, leaving an additional large free deck area. The worktable is equipped with a 45t pipeline end terminal (PLET) skidding system to transfer PLETS and other pipeline-related equipment into the firing line.

Several components have been integrated in the tower. Two abandon and recovery (A&R) traction winches have been installed for handling pipes and pipeline equipment. One system operates with a 138mm wire and 610t line pull capacity and the other with 76mm wire and 200t capacity. (The A&R system's storage winches are below deck). They are accompanied by A&R sheaves in the tower's top.

In addition, an underbender chute and top-mounted aligner chute gradually bend and bring pipes to the tower's two 275t tensioners, which transport the pipe either through the moonpool, or to the work platform and/or the PLET handling system. A crane on top of the tower can assist operations. One of the design criteria of the vessel is the limited air draught of 48m, needed for passing a bridge on the way to the pipe loading location. In order to achieve this air draught, the A&R post, top aligner and tower top crane can be tilted to a bridge passage position.

During laying operations pipe is fed to the underbender chute from one of the two underdeck carousels through an arrangement of winches and a pre-tensioner on deck. If a pipe is entirely spooled off it can be kept in the friction hang-off clamp (FHOC) in the moonpool, ready to connect to a new pipe and to continue the laying process. During recovery of a pipe, the pipe is picked up from the sea bottom with the aid of the A&R winch, followed in general by a sequence of actions and handlings, reverse to that described above.

Two owner-delivered remote operated vehicles (ROV) are also installed on board and can observe the underwater actions by CCTV – the monitors are installed at several locations on board. The ROVs are also equipped to carry out underwater service work at depths of up to 3,000m. They are operated from the ROV control room, which has been integrated in the vessel accommodation.

The active heave compensated main crane has a capacity of 250t. The auxiliary crane at the stern has a capacity of 20t.

The lay towers were manufactured and outfitted in the production hall of IHC Holland in Sliedrecht and towed from there to the yard in Krimpen aan den IJssel, where they were lifted on board as a whole (*figure 7*). Special provisions warrant good access to every system component for repair and maintenance.

The entire VLS's electrical and hydraulic systems are controlled by an autonomous and integrated PLC/SCADA control system designed and programmed by IHC EB, in which the company's experience with pipelaying has been realised. In particular, the speed, tension and clamping pressure of pipes are carefully monitored and controlled in order not to cause damage. Remote software access provides the possibility of fault diagnosis and/or upgrades.

For spooling operations during loading and unloading of pipes, two locally controlled 20t spooling tensioners are installed on the aft deck (*figure 8*).

A separate, but essential part of the mission equipment is the pipeline flushing and testing spread. This system can generate either high volumes at approximately 10bar, and/or high pressures of 1,034bar at low volumes. A smaller umbilical flushing and pressure testing system can also test umbilicals at maximum pressures of 1,034bar. High pressure piping for this system has been installed by IHC Piping.

The electrical and automation system

The six 6.6kV-60Hz medium voltage (MV) generator sets (*figures 9-10*) provide power to two separate MV main switchboards (*figures 11-12*). A ring bus can be created by means of bus tie breakers. Consequently all generators can run in parallel with load sharing, but they and all users can be split in separate islands too. The configuration complies with DP2 requirements while it limits propulsion energy failure to the loss of one generator and one thruster in the worst case.

The 690VAC thrusters are fed from either of these main switchboards by transformers, which supply water-cooled

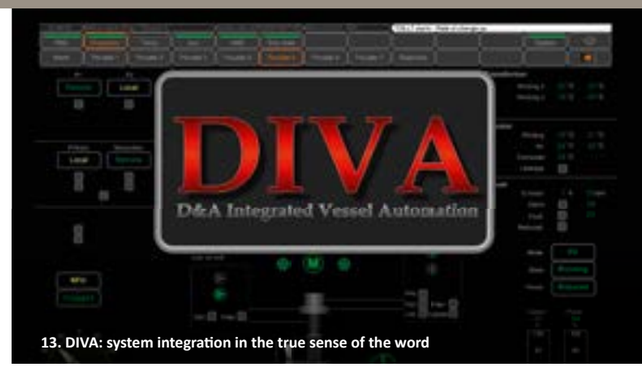
8. Spooling tensioners facilitate loading and unloading of pipes

9. One of the 6.6kV, 4,100kVA generator sets during installation on board…

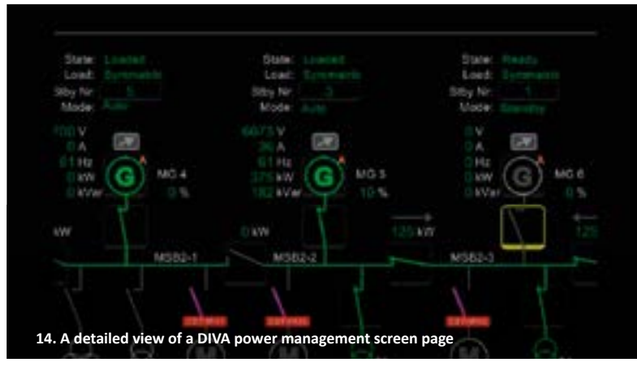
10. …and in full service

11. MV main switchboard

12. MV main switchboard in detail



13. DIVA: system integration in the true sense of the word



14. A detailed view of a DIVA power management screen page

variable frequency drives (VFD) with 12 pulse input diode rectifiers, preventing harmonic distortion as much as possible. With these VFDs, designed by IHC Drives & Automation (IHC D&A), the speed of any thruster can be accurately controlled which is essential for DP performance.

The MV switchboards also provide power to the pipelay equipment and the main deck crane, and supply two low voltage (LV) 440VAC switchboards, which provide power to the ROV systems and auxiliaries such as compressors, pumps, the HVAC installation, etc. Finally they feed two auxiliary switchboards and rotating converters for the 230VAC normal and clean power grids. The LV switchboards can also be powered by the 1,875kVA emergency/harbour generator. Consequently, if no MV generator is running they can autonomously power the LV power grid, including all control, monitoring, nautical and safety equipment.

System integration of platform and mission equipment in the true sense of the word has been achieved by IHC D&A's Integrated Vessel Automation (DIVA) vessel management system (*figure 13*). DIVA integrates the vessel's power management (PMS), the DP system and the alarm monitoring system (AMS) with the control and monitoring logics of the main switchboards and VFDs, and communicates with the IHC EB lay tower control system. The reliable DIVA has a redundant glass fibre communication backbone and can handle multiple distributed PLC/SCADA combinations. Parallel to and prior to installation on board, it is entirely simulated in IHC D&A's office. This saves a large number of common and time-consuming commissioning problems.

For example, DIVA provides fault analysis of the MV main switchboards and subsequent smart switching of components. In addition it regulates power by monitoring DP and lay equipment energy requirements, compensating for potential shortages by regulating speeds and/or smart switching auxiliaries and non-essentials (*figure 14*). Of course, the integrated AMS fully complies with class requirements. SCADA screens can be located anywhere on the vessel and – together with CCTV information – considerably ease the work of inspectors, surveyors, engineers and operators.

Conclusion

With the delivery of these pipelay vessels, Sapura Navegação Marítima can make a very versatile contribution to the current and future development of subsea oil fields. Thanks to its input and IHC's integrated design, it has obtained optimised tools for that purpose. Named after the most desirable and beautiful gems in Brazil and considering their origin, perhaps they could be named royal vessels? We wish the three delivered vessels – and the seven to come – and their crew all the best for now and the future.

Principal characteristics	
Classification	Lloyds Register of Shipping ✠100A1 Pipe Laying Ship, UD strengthened, Helicopter Landing Area, EP, ✠LMC, UMS, ICC, DP(AA), CAC(3), NAV-1, IBS, *IWS
Length overall (hull)	145.95m
Breadth	29.94m
Main deck above base	13m
Draught International Freeboard	7.6 - 8.3m
Air Draught	48m
Helideck suitable for	Sikorsky S92 or equivalent
Vertical lay system tensioner capacity	550t at 80-90 degrees, 100-630mm pipe diameter max.
A&R winch capacity	1 x 610t, 1 x 200t
Hang Off Clamp (HOC) capacity	610t
Underdeck basket capacity	1 x 2,500t – 1 x 1,500t
Maximum pipe laying depth	2,500m
AHC/ACT main crane SWL	250t @ 12m
Moonpool area	10 x 7.5m
Permissible deck load	10t/m² in the landing area of the main crane, 5/tm² other areas
Total installed power	23,540kWe
Speed at design draught	13.6 knots
Accommodation	120 people

References

[1] "SEVEN OCEANS: Deepwater rigid pipelay vessel". *Ports and Dredging 173*. IHC Merwede, Sliedrecht, The Netherlands, 2009. 26-31.

[2] "SEVEN PACIFIC: Compact integrated offshore construction and pipelay vessel". *Ports and Dredging 177*. IHC Merwede, Sliedrecht, The Netherlands, 2011. 20-25.

IHC training simulators for dredging and offshore

1. The CONGO RIVER: outside-view example of the DEME simulator

IHC Systems has recently added three projects to its successful training simulator track record [1]. The first was ordered by DEME for the simulation of multiple trailing suction hopper dredgers (TSHDs). The second accompanies the delivery of the cutter suction dredger (CSD) AL BAHAR for Huta Marine Works (page 22). And the last is a simulator for training of pipelay operators on board the five 550t pipelaying vessels (PLV), which have already been delivered and/or are under construction for Sapura Navegação Marítima (page 8).

These reflect IHC's capability to supplement every delivery in the company's main markets with simulators. They provide added value to IHC's customers in light of the ongoing retirement of many people within the industry and the subsequent scarcity of well-trained crew, as well as the high capital costs and risks involved with training inexperienced personnel in the field.

Generic arrangement

IHC Systems' simulators – irrespective of whether they are for TSHDs, CSDs, excavators or offshore vessels – have a generic basic set-up:

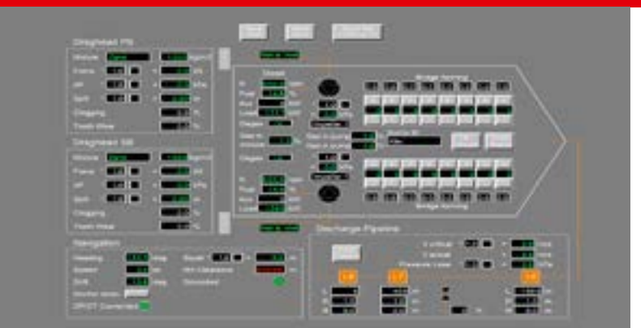
- trainee consoles, which are 90-99% identical to those on the vessels for which the training is intended
- a trainer desk, on which the trainer can influence the behaviour of the simulator and the process
- large fore and/or aft outside-view displays, providing the perception that "I am on the bridge"
- a classroom projector and screen for co-trainees attending a colleague's training session
- the adjacent computer hardware and software, network and network switches.

The trainer – a staff member of the customer – should be accustomed to every aspect of the training, processes and equipment to be taught. On his or her desk, equipped with one or more flat-screen displays, the trainer can alter every video page of either the simulator or the outside views to accommodate every location within the arrangement. The water in the outside views can be "drained", enabling the underwater situation to be "viewed". By means of freely moving "cameras", detailed bird's-eye views and simulated CCTV images can also be added to the outside view. In this way, the attention of the trainee and/or co-trainees may be drawn to specific situations or educational targets.

The recently renewed trainer interface (*figure 2*) – of which all simulators benefit – enables the trainer to influence a configurable set of process parameters or values. He may also introduce failures, such as a broken or clogged pipe, a leaking hydraulic cylinder or a stalling diesel engine, for example. This is a perfect means to provide the trainee with knowledge and resolution to resolve extraordinary or emergency situations.

In addition, the trainer can influence the weather (sunny, cloudy, rainy, snowy or foggy), sea state, tide, and sun azimuth and altitude. These environments appear on the outside view in the phenomena of light, moving shadows, visibility and vessel movements. He may also configure the path, speed and draught of up to 10 additional vessels – or dolphins or birds – surrounding the "working" vessel and can therefore alter the amount of traffic to influence the trainee's decisions. These are realistically modelled from ships in the owner's fleet or IHC-built vessels. The various options contribute to the feeling of a realistic scenario (*figure 1*).

Innovative vessels



2. The configurable trainer interface enables the training to be influenced in nearly every aspect

4. Configurable top plate-mimicking touchscreens provide a realistic adaptation to the particular vessels' console components

5. The beautiful AL SAKAB is one of the dredgers simulated in the Huta Marine Works' simulator

3. The basic part of the DEME trainee console reflects those of the MARIEKE, BRABO and CONGO RIVER

6. A process page on the AL BAHAR's SCADA system

The trainer interface is also used to prepare training sessions. "Operational areas" – reflected in the outside views and bottom profile – can be prepared offline, without the need to run the simulator. They can be uploaded as scalable digital terrain models (DTMs), derived from a variety of real survey systems, such as IHC Systems' DTPS [2] for example, and easily located in the real geographical world. Detailed obstacles, quay walls or real harbour environments can be added too.

TSHD simulator

The optimal operation of a TSHD is governed by a combination of navigational accuracy, trailing speed, draghead positioning, dredge pump behaviour and overflow regime. This involves many pieces of auxiliary equipment, such as flushing, gland and jet pumps, gate valves and suction pipe gantries, winches and swell compensator, as well as bottom and self-emptying doors.

Controlling these processes implies a huge knowledge of technical systems and the influence of their behaviour on TSHD production. Even the relationship between dredging and sailing times can be decisive in the efficiency and profitability of the vessel – not to mention the necessity to prevent damage, injuries, downtime and risks. To influence this intertwined combination of factors, numerous manual and automatic instrumentation, monitoring and automation tools are integrated and installed on board.

The purpose of DEME's new simulator is to make navigators/operators aware of all this and teach them to achieve optimum performance from such costly equipment. It enables operators to be trained for three types of vessel in the fleet, for which the MARIEKE (5,600m^3), BRABO (10,890m^3), and CONGO RIVER (30,000m^3, two suction tubes) are typical. As these have one-man operated bridges, the navigator and dredge operator functions are integrated. The BRABO's and CONGO RIVER's DP/DT systems are also simulated. During training for the MARIEKE, it is used as a sailing simulator.

Operations such as dredging, backfilling, free sailing, loaded sailing, shore discharging, rainbowing and dumping can be exercised on the simulator, either in several DP/DT modes or without DP.

One particular feature is that the trainee console automatically adapts to any of the three vessels without replacing any hardware component. Components that differ between ships are not fixed in the steel top plate, but instead are displayed in top plate-mimicking touchscreens (*figures 3-4*) that are reconfigured accordingly as soon as the simulator is loaded. The impression of touching these components is surprisingly close to reality, except for turning knobs. Trainees have expressed positive impressions regarding this feature.

The simulator software has evolved with certain key features. It now enables the user to load the entire PLC/SCADA simulation of multiple vessels instead of loading one and then scaling it for other ships, as with the older 'semi-multiple-vessel' version. The physical models have evolved in response to recent developments, especially the draghead and hydromechanical models. The soil model allows for a second layer of different soil under the surface of the sea floor. Boulders and other obstacles can of course be located in these environments.

The system has hugely benefitted from the excellent relationship and extensive collaboration between IHC Systems and DEME. It has been installed in the latter's newly built simulator room in Zwijndrecht, Belgium. It is currently in full service and DEME has chosen not to apply the classroom part.

CSD simulator

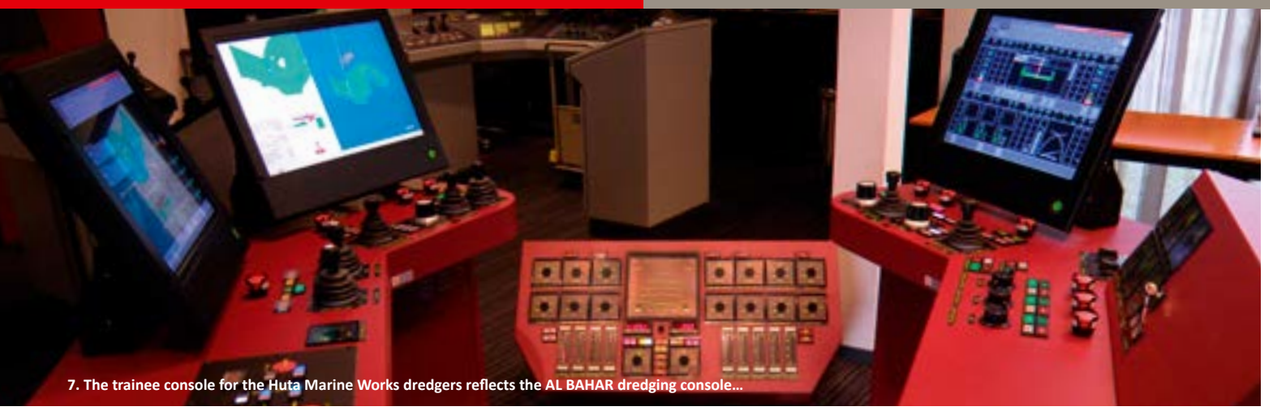
Not entirely different to TSHDs, the optimal operation of a CSD is governed by a combination of positioning accuracy, swing speed, and cutter and dredge pump behaviour. This involves such pieces of equipment as flushing, gland and jet pumps, gate valves, a number of winches and anchors, and last but not least, the spuds and spudcarrier, and the discharge pipeline.

In a similar manner, these systems influence the efficiency and profitability of the dredger, and should serve to prevent damage, injuries, downtime and risks. Not surprisingly, Huta Marine Works – which has added three modern-operated CSDs to its fleet – ordered a CSD simulator that accompanies the delivery of the 23,545kW AL BAHAR C/D HUTA 12 (page 22). It also enables training for the operation of the 16,500kW AL SAKAB C/D HUTA 9 (*figure 5*) that IHC delivered in 2010, and the existing 15,871kW HUTA 14, which will soon receive a similar modern control system (*figure 6*).

All of the usual CSD operations can be exercised, including: breaching in, starting up, continuing and shutting off the discharge process; dredging different soil types; shifting spud positions; and anchoring. In addition, the spud-tilting process between the working and transportation positions, and *vice versa*, is explained in detail.

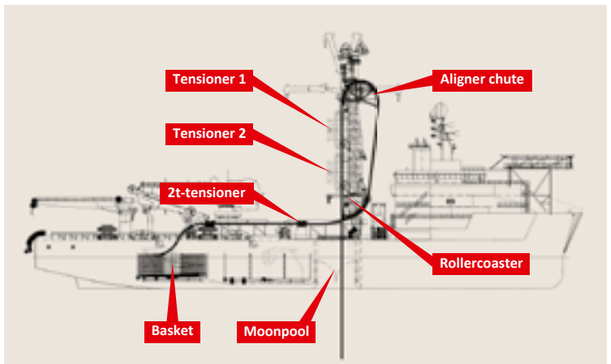
The trainee console (*figures 7-8*) is a copy of the AL BAHAR dredging console, which sufficiently covers the consoles of the other two dredgers. However, the multiple-vessel simulator software is used fully.

Special features include the trainer's ability to block the discharge pipeline and the presentation of the discharge site in the outside view, including bulldozers and other auxiliary vehicles. It allows the trainee to "see" the outcome of his actions. Another specialty is the presentation of the diesel engines' fuel consumption, expressed in relation to the amount of material transported. This will certainly enhance

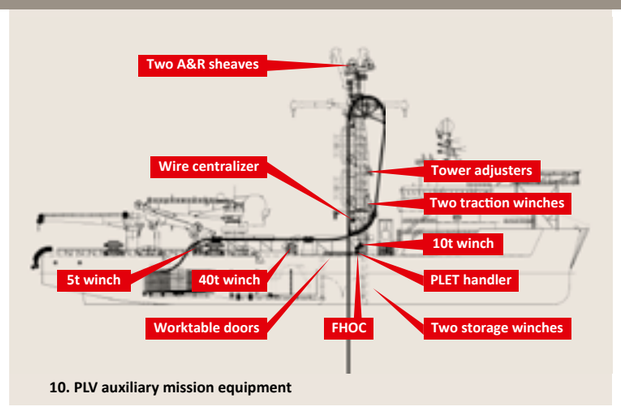


7. The trainee console for the Huta Marine Works dredgers reflects the AL BAHAR dredging console...

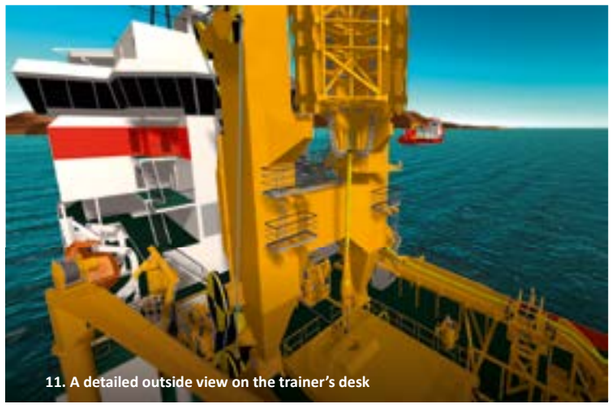
8. ...and is a fine place for Mr Tag Saleh, Huta Marine Works' Director for Dredging, Reclamation & Marine Facilities, to demonstrate his skills



9. PLV essential mission equipment

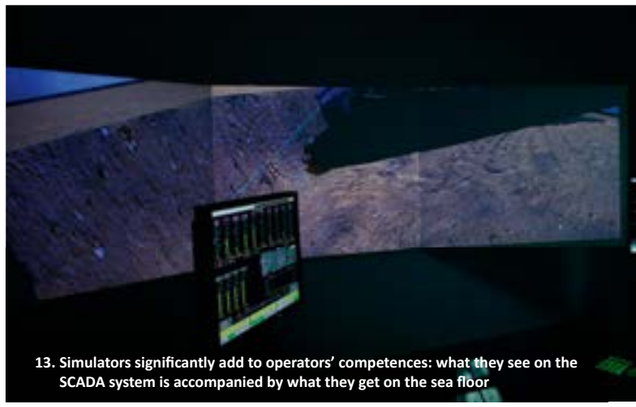


10. PLV auxiliary mission equipment



11. A detailed outside view on the trainer's desk

12. Pipelay operator trainee console and outside view



13. Simulators significantly add to operators' competences: what they see on the SCADA system is accompanied by what they get on the sea floor

the operators' sense of efficiency. As the AL BAHAR has IHC Systems' 3D-Viewer on board, this is also presented on the trainee console.

The features of the generic arrangement and the benefits of the enhanced models also add to the value of this simulator.

PLV simulator

A pipelaying operation – once initiated by the operations room – involves the close cooperation of the pipelay control room (PCR) and many deck crew, manually controlling such equipment as the storage basket, roller coaster, worktable doors, aligner chute and several winches, among others (*figures 9-10*).

In these operations, the operator in the PCR is the spider in the web. He controls the pipelay tower with its two tensioners and abandon and recovery (A&R) system, and monitors nearly all of the pipelay equipment, using SCADA screens. From the PCR and with the help of the vessel's communication system, he commands the other crew. Their task is generally to guide the pipe from the basket to the tensioner, which is the starting point of further transportation by the pipelay tower.

Such operations involve high levels of risk. They require the pipes to be repeatedly taken over by ropes, winches and tensioners, which are almost all man-made operations. If not properly tensioned, swaying pipe ends – up to diameters of 648mm – and/or leg-thick steel ropes may damage structures or equipment and cause downtime, injuries or even fatalities. Wind, weather and sea state may only add to such risks. Another example is the loss of a pipe, which generates extremely high costs for recovery.

Consequently the PLV simulator – designed in collaboration with Sapura Navegação Marítima and delivered at the end of October 2014 – differs from the above dredge simulators in that its main goal is not optimisation of productivity. Instead, its primary purpose is to gain awareness of, and experience with, the detailed procedures and protocols concerning operational safety and the prevention of downtime and pipe losses. This may of course improve productivity as a spin-off, but that is of secondary importance – safety is the keyword.

The nature of multiple-person operations also dictates a different role for the trainer. He not only coaches the trainee, but also takes up the role of the deck crew. Subsequently the trainer interface is not only equipped with generic simulation-influencing facilities, but also with a number of "soft push buttons" with which the trainer can "control" deck and underdeck equipment and actions in a simplified way.

Examples are the aligner chute, wire centraliser and "connecting" or "disconnecting" ropes to and from the pipe. The PCR trainee calls for these actions by telephone, which replaces the vessel's communication system in the simulator. Indeed, developing the operator's communication skills is also a goal. More experienced trainees may use a trainer interface repeater to "execute" the deck crew actions.

Failures initiated by the trainer have the purpose to show the trainees how to correctly diagnose and either to intercept by themselves, or correctly command the "deck crew" (the trainer) to do so.

The trainee exclusively controls the PCR functions. For that purpose, a 99% exact copy of the equipment in the PCR is at his disposal. This includes the pipelay control console for the IHC EB lay tower, including its tensioners (*figure 12*). Two large outside-view displays simulate the view from the PCR's windows. The usual CCTV displays are also installed and simulated, however they are controlled slightly differently.

In an interactive training session between the operator and deck crew, many pipelay operations may be learned, such as:

- pipe initiation
- pipe abandonment
- pipe recovery
- pipe-to-pipe connection
- and adding begin or end PLETs (pipeline end terminals).

The building of this simulator succeeded thanks to extensive collaboration between the owner, IHC Offshore & Marine, IHC Systems, IHC D&A, IHC Engineering Business and SAS Offshore. IHC Systems' Project Manager confirmed the extremely satisfying nature of this collaboration. It provided an accurate understanding of what the owner would require to be trained – and what vessel functions purposely should *not* be simulated.

In addition, the technical and accuracy requirements could be mutually established. It resulted in an ultimately accurate simulation of (swaying) pipe and rope behaviour, at least to the astonishment of the author of this feature, who saw an insufficiently tensioned pipe ruin a deckhouse wing. Fortunately, it was only on a video screen...

Conclusion

By supplying three innovative simulators, IHC has again proved that the company always has the benefit of its customers in mind. It adds considerable value by offering systems that significantly contribute to the optimisation and safety of their operations with its baseline products (*figures 11-13*).

References

[1] For example refer to the issues E166, E171 and E179 of *Ports and Dredging*. IHC Merwede, Sliedrecht, The Netherlands, 2006-2012.

[2] "3D-Viewer: innovative tool for improved subsea operations". *IHC Merwede Insight E4*. IHC Merwede, Sliedrecht, The Netherlands, 2014. 32-35.

CSD for Huta Marine Works: AL BAHAR C/D HUTA 12 commissioned

1. AL BAHAR C/D HUTA 12 during sea trials

Royal IHC (IHC) and Huta Marine Works maintain close working relationships. This may be demonstrated by the fact that the largest dredging contractor in Saudi Arabia has filled the largest fleet in the Kingdom with several IHC-built cutter suction dredgers (CSDs) in the course of its history.

These include: the HUTA 1, one of the four IHC Beaver 8000s ever built; the IHC Van Rees dredger HUTA 4; the HUTA 10, built at the former IHC Verschure yard; and last but not least, the AL SAKAB C/D HUTA 9. The latter was delivered in 2010 and has been described within the framework of rock-cutting CSDs in reference [1]. An unusual detail is that none of these three vessels – representing approximately 43,500kW of cutting and pumping power – was launched from the same slipway, i.e. they have 'seen' almost all IHC shipyards.

With these and other dredgers, Huta Marine Works carries out capital, maintenance, environmental and trench dredging projects. It is involved in harbour construction, marine infrastructure, coastal developments, industrial installations and such services as offshore piling. In 2013 a second-hand self-propelled CSD, the HUTA 14, was acquired from a Dutch dredging contractor. In addition, another self-propelled dredger was ordered from IHC and commissioned in summer 2014. Her name is AL BAHAR C/D HUTA 12 (*figure 1*).

Competitively priced, this dredger – packed with proven technology – will substantially contribute to the Huta Marine Works fleet, in that she adds nearly 55% to the power of IHC dredgers already in use. She took only 23 months to build after the contract was signed. The keel was laid in September 2013. In March 2014 the AL BAHAR was launched, and in September she was handed over to her new owner after successful sea trials (*figures 1, 5, 11*).

Outline of the dredging installation

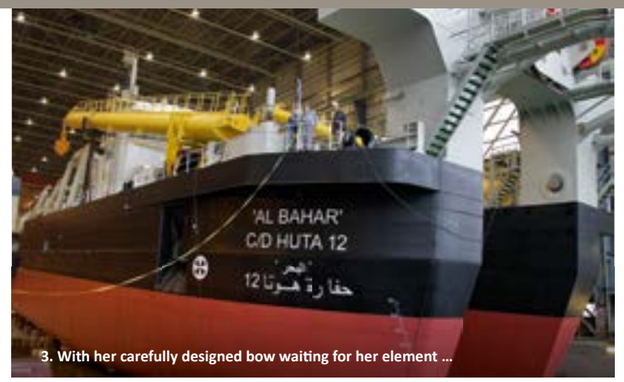
The 23,575kW diesel-electric powered dredger can be characterised as a no-nonsense self-propelled CSD with rock-cutting capabilities. The completely electric-driven dredging installation includes one single-walled submersible dredge pump and two double-walled inboard dredge pumps, a rock cutter installation, fore side winches and ladder winches. The dredge pumps can be 'switched' in and out of the mixture-conveying circuit by slide valves and/or bypass pipe pieces in order to accommodate pumping a wide variety of soil types and discharge distances. On-board dredge pipelines are manufactured from mild steel with internal Maxidur® 5 liners to prevent wear.

Together with the propulsion installation, hydraulically operated spuds, spudcarrier and anchor booms provide beneficial opportunities in the field of positioning, mobilisation and autonomy of operations. Two hydraulic power units (HPU) provide oil as close to the consumers as possible. An integrated electrical and control & automation system completes the vessel.

The spuds are tiltable by the vessel's own means. Space and buoyancy are reserved for the future installation of a barge-loading installation. The nature of dredging works encountered by Huta Marine Works urges them to sometimes use the cutter above the waterline. In such cases, the normal cooling of the cutter by the surrounding water is non-existent. Therefore, the cumulative outputs of the emergency firefighting, general service and bilge/firefighting pumps can provide cooling water through a couple of nozzles on the cutter maintenance platform. Nevertheless, the grating and grinding sounds generated by these operations

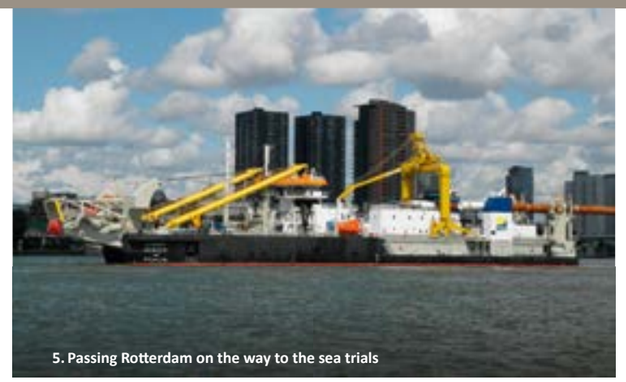
Innovative vessels

2. Azimuth thrusters make her highly manoeuvrable



3. With her carefully designed bow waiting for her element …

4. … and eager she was!



5. Passing Rotterdam on the way to the sea trials

6. An IHC DMC work boat was part of the delivery

7. The submerged and in-board dredge pumps are mutually interchangeable, and also with the pumps of the AL SAKAB

8. The cabling to the cutter ladder was a challenge

send shivers down one's spine – even on a movie. A final special feature to mention is the dredger's fuel oil supply line, which enables a controlled supply of fuel to other vessels on a dredging job.

Propulsion particulars

Figures 2 and 3, taken just before the launch, reveal interesting features. The sailing direction was determined with the ladder in the foreship and the spuds in the aft ship. There are a number of reasons for doing this – or the contrary. A summary of the discussion on this issue was presented in reference [2]. For the current vessel, it required free lines of sight from the bridge over the ladder gantry. This was achieved by adding a converter room underneath the wheelhouse, while simultaneously lowering the ladder gantry's profile, leading the ladder hoisting winch wires over the gantry instead of below it. The deck crane – which is subsequently a high one – is collapsible to enable the passing of bridges. A hydraulically erectable telescopic radar mast was developed in order to prevent radar shadow. These measures resulted in a ship with really elegant lines (*figures 3, 5, 12*).

The AL BAHAR is propelled by two electrically driven azimuth thrusters (*figure 2*), which can be removed afloat. Another particular feature is the specifically designed bow, which is modestly rounded (*figure 3*). It serves the balance between optimum buoyancy needed for carrying the heavy cutter ladder and hydrodynamic streamlining. It seems to work – a vessel, eager to meet her element, was observed during launch (*figure 4*).

Comprehensive delivery

Operating a CSD requires excellent planning, the deployment of many auxiliaries, good maintenance and appropriate training of the crew. From that perspective, Huta Marine Works not only purchased a dredger, but placed a comprehensive order. The delivery of the AL BAHAR was accompanied by: a survey boat; an IHC DMC-series workboat (*figure 6*); extensive initial spare parts; a training package; and a training simulator for installation at the company's premises in Saudi Arabia (see pages 16-21).

Huta Marine Works' strategy on maintenance had a large and beneficial impact on the dredger's design. It is clear that the more components that are standardised – within a dredger and the fleet – then the fewer components that are needed to be kept in stock, and the easier the maintenance logistics within the life cycle of vessels. Therefore, a multitude of AL BAHAR's major components are interchangeable. These include the electric cutter and submerged pump motors, and the electric ladder winch and fore-side winch motors. Naturally, both electric in-board dredge pumps and both azimuth thruster motors are mutually interchangeable.

In addition, the single-walled submersible dredge pump's housing is the same as the inner housing of the double-walled in-board pumps. In turn, all these IHC high-efficiency cutter special (HRCS) pumps (*figure 7*) are exactly the same as installed on the AL SAKAB, albeit running at higher power. Derived from this basic principle, all of the dredge pumps' wear parts are identical: the three-blade impellers for large ball passage; the shaft-side and suction-side wear plates; and even the pump-bearing blocks. Above the high-wear resistance of the pumps – achieved by the application of materials from the Maxidur® group – this interchangeability strategy will certainly contribute to the dredger's availability.

IHC's Training Institute for Dredging (TID) provides a training package for Huta Marine Works' operational crew and office personnel. This secures the efficient and safe operation of the dredger at high levels of productivity. Upon completion of the training, the Huta Marine Works crew will be able to effectively maintain the dredger, resulting in high uptime rates.

Prior to the delivery of the dredger, all project managers, project engineers and technical superintendents were trained in Saudi Arabia. The staff training covered the preparation, monitoring and planning of efficient dredging operations.

To become more familiar with the dredger's components and systems, and leading aspects in design, maintenance and repair of the vessel, the mechanical and electrical engineers received a four-week in-depth training programme from all relevant suppliers.

Following delivery of the dredger, TID will travel to Saudi Arabia again to perform on-the-job equipment training. IHC's technical experts shall offer practical training in automation systems (VMS/PMS/AMS), switchboards, machines, sensors, dredging automation (DTPS/DPM/ACC) and control philosophy.

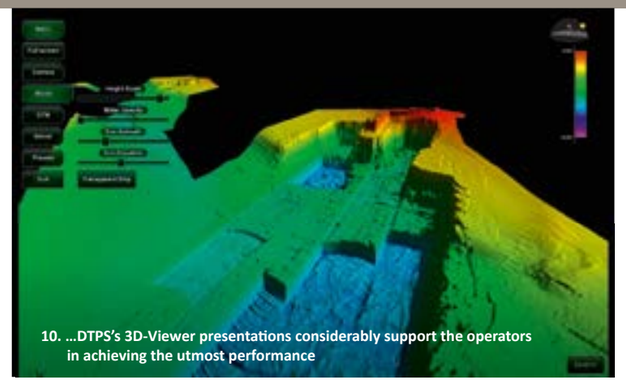
The comprehensive package also includes on-the-job training for the operators of the other Huta Marine Works dredgers. An experienced dredge master will visit the vessels and manage practical on-board sessions, resulting in a more economic and safe operation, as well as an understanding of the principal processes in dredging operations.

Finally, TID delivers a package for the training simulator (see pages 16-21), from which a variety of dredging scenarios can be studied. Project conditions can be altered to match real-life situations, enabling participants to understand what the results and effects of their actions would be. Hazardous situations can be experienced without danger, risk or loss of production.

Integrated electrics, control & automation

IHC Drives & Automation and IHC Systems integrated the AL BAHAR's electrical installation, and the control & automation system. This included the 690VAC main power generators, main switchboards, 400VAC and 230VAC power grids and the electrical installation. A clean 400VAC grid was achieved by the application of a static converter. All major electric motors – including those of the gland and flushing pumps – are of the

9. The IHC DPM®, ACC® and…



10. …DTPS's 3D-Viewer presentations considerably support the operators in achieving the utmost performance

11. With free lines of sight from the bridge…

12. …the AL BAHAR easily finds her way among other vessels, sailing to the future

squirrel-cage type and are speed and/or power controlled by IHC D&A's water-cooled variable frequency drives.

A power management system was provided, which monitors the generator load and avoids overload by limiting power consumption of certain consumers. This task is eased by the application of variable frequency drives for all major consumers, and integrated PLC/SCADA control of both the electrical installation, and the dredging control & automation systems. This arrangement enables control and measurement signals to be distributed – and used – over the entire ship without conversions or interfaces. The Ethernet control network and PLC processors are redundant to warrant the highest availability. The alarm-monitoring system (AMS) was also integrated and received class approval.

Providing energy to consumers – such as the high-powered propulsion thrusters, dredge pumps and cutter at the 690VAC low voltage – meant a serious challenge to the bus-tie, breakers and electrical cable installation – a challenge that was accepted in appropriate fashion. The many flexible cables between the vessel and the cutter ladder were connected to interconnection boxes in the 'dry' interior of the dredger (*figure 8*). The additional work – implied by this solution – will be compensated by the benefits to maintenance and replacement of unexpectedly damaged cables during the vessel's service life.

The customer's wish to combine the easy intelligibility of the on-board installations with taking as many of the worries off the crew as possible, has resulted in a high degree of dredge process automation. Besides the usual basic instrumentation and control consoles, the dredge profile monitor (IHC DPM®) and automatic cutter controller (IHC ACC®) functions have been integrated in the PLC/SCADA system, accompanied by a dredged track presentation system (IHC DTPS) with 3D-Viewer [3].

These systems jointly provide the operator with high-accuracy information about where to dredge and where dredging has had sufficient results within tolerances. In addition, they automatically control the swing speed, slice thickness and following-the-dredge-profile with the cutter ladder and spud stepping automation. Pump speed automation, and control of vacuum and intermediate relief valves prevent cavitation, choking of the pumps and blockage of the discharge pipeline. In summary, this integration serves the optimal adaptation of the dredger's yield to the prevailing soil properties, suction conditions and discharge pipeline length. The utmost and efficient utilisation of all on-board systems – saving fuel consumption, preventing emissions and the most economic exploitation of the AL BAHAR – is the final result (*figures 9-10*).

Finally…

IHC Insight had the opportunity to meet members of Huta Marine Works' building team, who have been accompanying the entire design and building process on location. The team members demonstrate an astonishing familiarity with every aspect and technical detail, from strength calculations and switchboards to the slide valves, and from the diesel engines to the anchors and work platforms on deck.

By critically conducting the entire process, the building team has contributed to the solution of practical issues, maintainability, and in general, the quality of the dredger. They appreciate the skills and enthusiasm of the IHC people on the shop floor with whom they had to cooperate on a daily basis.

One of the design features for which they expressed great appreciation is the feed of gland water through the diesel engine cooling system. The team expects this to contribute considerably to the prevention of wear. They are convinced that the company has gained a complete dredger, suited for the job.

The editorial board of *IHC Insight* congratulates Huta Marine Works for this fantastic new dredger, and wishes her and her crew all the best for the future (*figures 11-12*).

Principal characteristics	AL BAHAR C/D HUTA 12
Length overall	approx. 122.5m
Hull length	105m
Beam	21.7m
Average draught	5m
Classification	BV ✠ Hull ✠ Mach, Dredger, unrestricted navigation, AUT-UMS
Dredging depth	28m maximum
Suction and discharge pipe diameter	900mm
Cutter power	3,500kW
Total installed power	23,545kW (ISO)
Sailing speed	9 knots
Accommodation	40 people

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[1] "Power girls: cutter suction dredgers for rock cutting". *Ports and Dredging 175*. IHC Merwede, Sliedrecht, The Netherlands, 2010. 16-19

[2] "AMBIORIX: sister ship of DEME's most powerful CSD". *IHC Merwede Insight E4*. IHC Merwede, Sliedrecht, The Netherlands, 2014. 15s.

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Hi-Traq: innovative subsea trencher from IHC Engineering Business

1. The Hi-Traq Demonstrator appears on the specially designed test site

Royal IHC (IHC) has officially introduced the world's first steerable four-tracked subsea trencher, specifically developed for shallow water operations and targeted at inter-array and export cable burial in offshore wind farms. The highly versatile multi-tooling platform provides unequalled manoeuvring and traction capabilities for cable burial and other operational subsea challenges (*figure 1*).

The patented Hi-Traq – named after its high traction properties – is a product of IHC's UK subsidiary, IHC Engineering Business (IHC EB). It was developed with financial assistance from the IHC group and further funding from the European Regional Development Fund.

IHC EB designs and builds specialist equipment for the offshore oil and gas, submarine telecoms and renewables industries. The company's scope of supply ranges from engineering, design, modifications and upgrades, to complete integrated ship systems. Most of the company's 230 employees operate from its UK headquarters in Stocksfield Hall, Northumberland. IHC EB also has a manufacturing and customer support base at Riverside Quay, Port of Tyne. This facility accommodates the assembly, testing, commissioning and installation of several major projects simultaneously. It offers IHC EB's customers a wide range of manufacturing, mobilisation and support services from one deep-water base.

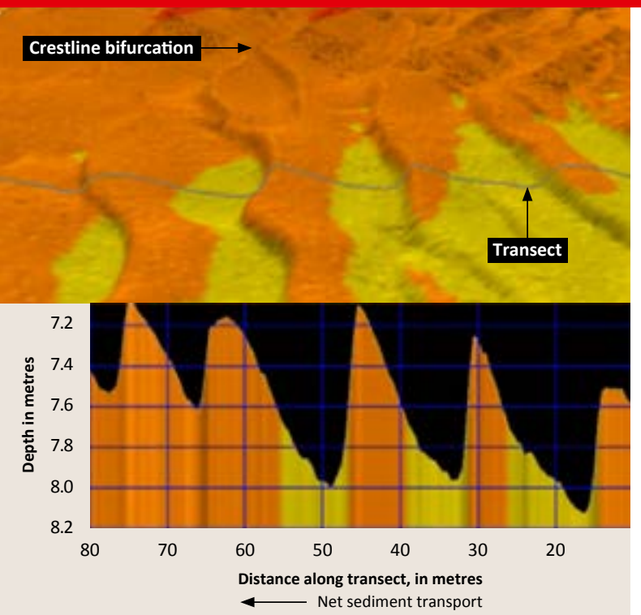
The company's passion for technology, innovation and quality has previously been recognised with highly esteemed awards. These include the British Engineering Excellence Awards (BEEA) Design Team of the Year; and the NOF Energy Innovation and Technology Award [1, 2]. Most recently, Hi-Traq has been nominated for the Mechanical Product of the Year Award at this year's BEEA.

Basic investigations on wind farms

Based on plans for increasing reliance on renewables, European governments have made key investments by installing numerous offshore wind farms surrounding the UK, Ireland and several countries on the continent. As leaders in offshore renewable power, European countries are closely monitored for the progress they make in offshore wind, which has helped to drive a growth in the global market.

As yet, however, the price of electric power generated by renewables cannot compete commercially with energy obtained from fossil fuel-driven generators. This state of affairs continually revives societal discussion on the usefulness of renewables. For industry professionals, this debate points to a need to reduce costs and risks of offshore wind farms in order to achieve true competitiveness.

Subsea cable installation accounts for approximately 10% of these costs. There are two types of cables that must be buried on any offshore wind farm: inter-array cables – running from turbine to turbine and connecting to the offshore substation – and large export cables, which connect the substations to an onshore station, or similar connection onshore.



2. Seabed topography can vary considerably in shallow water environments, forming sand waves and megaripples

3. Pivoting tracks following undulating terrain

4. Four-track system facilitates smooth transition over crests

To establish the requirements for a shallow water trencher, IHC EB investigated the issues and problems faced during past offshore wind projects. The following observations were established as key factors that influence the cable installation costs in shallow water conditions (12-50m – typical offshore wind farm water depths):

- high winds and strong wave action can hinder the launch and recovery operations of trenching assets
- very strong currents at the seabed can lift and push vehicles off course, which can subsequently damage cables
- significant seabed topography variations – such as sand waves and megaripples (*figure 2*) – can hinder the manoeuvrability of vehicles and lead to unstable trenches, which are liable to collapse
- the soil conditions at offshore renewable locations can often vary over relatively short distances – sand, silt, mud, clay and rock require different trenching techniques (and vehicles) and therefore drive up installation costs and project risk
- cables have previously been damaged or over-exerted past their loading specifications due to significant mechanical stresses caused by vehicles negotiating challenging terrain irregularities during trenching
- typical inter-array cable routing includes short-radius bends that cannot be trenched using conventional equipment and often require second-end operations, driving up installation costs.

Appearance of the Hi-Traq

The result of this investigation was to outline a variety of parameters for the design of a dedicated shallow-water trencher aimed at reducing offshore wind project costs and risk. In summary these include: increased operational windows; vehicle stability on the seabed; avoiding second-end operations; high vehicle manoeuvrability; simple multi-tool exchange; a tilting mechanical cutter for vertical trenches; and a carefully monitored and delicate cable-handling system. Additionally, strict compliance to the rules and regulations involved with wind farm installation was paramount.

From these ‘functional specifications’, the Hi-Traq gradually appeared as the ultimate trenching vehicle for shallow water offshore wind farm installation. A feature not essential to offshore wind, but useful for further applications, Hi-Traq has the capacity to operate at deeper depths up to 1,000m for work in the offshore oil and gas industry without major adaptations.

Roll-and-pitch compensation

The two most prominent features of the Hi-Traq are its four independently driven undercarriage-units and the unique self-levelling system. These offer a number of benefits in relation to the problems as described above.

Firstly the four undercarriage units pivot about the centre to enable the vehicle to navigate uneven seabed profiles (*figure 3*), slopes and peaks, as well as allowing the vehicle to make smooth transitions between slopes and plains without affecting the trenching tool (*figure 4*). The four independent undercarriages ensure the largest possible ground surface contact area, even in transitional areas, providing increased traction and reduced vehicle sinkage. Unlike traditional two-track vehicles, Hi-Traq smoothly climbs slopes, and tackles crests and rises, without sudden pitching. This feature considerably decreases the risk of exceeding the allowable forces on the product during burial.

The X-direction stability achieved in this way is accompanied by intricate steering options that offer the pilots a range of manoeuvring options and stability in the Y-direction.

- Wagon-steering mode allows the vehicle to trench smoothly around bends with radiuses of only 10 metres, which is significantly shorter than existing vehicle capabilities. This reduces the need for second-end operations such as rock dumping or the laying of a concrete mattress. This mode also enables the vehicle to avoid obstacles while trenching and to trench-in any cable slack generated during the cablelaying process (*figure 5*).
- Crab-steering is used for positioning the vehicle during deployment over the product. Furthermore, while traversing steep slopes, the vehicle can crab the tracks up the slope, which compensates for slippage.
- Articulated skid steering provides increased flexibility when it comes to manoeuvring on the seabed and true ‘on-the-spot’ turning, for example aligning the Hi-Traq vehicle with the cable before trenching operations.

Two additional features add to the stability of the Hi-Traq: the carefully calculated submerged weight compensates for the upward forces exerted by the trenching tool; and the open profile of the vehicle makes it relatively insensitive to the drag forces caused by the strong subsea currents.

Finally, further stability in the roll-and-pitch motion is obtained by the self-levelling system, comprised of an arrangement of complex wishbone geometry and hydraulic cylinders. The system enables the chassis to remain level while traversing slopes of up to 20 degrees and navigating over uneven and/or out-of-phase mounds.

The self-levelling system is focused around a virtual pivot point at the ground-to-cutter interface. This enables the cutter chain to remain vertical while traversing slopes, leading to a more stable trench wall and therefore preventing the chance of trench collapse. Additionally, the system controls the depth of the cutter when travelling over uneven surfaces to ensure a constant trench depth. This reduces the chance of uneven loading on the cable while simultaneously ensuring that the required minimum trench depth is achieved (*figure 6*).

Centrally mounted and easily interchangeable tools

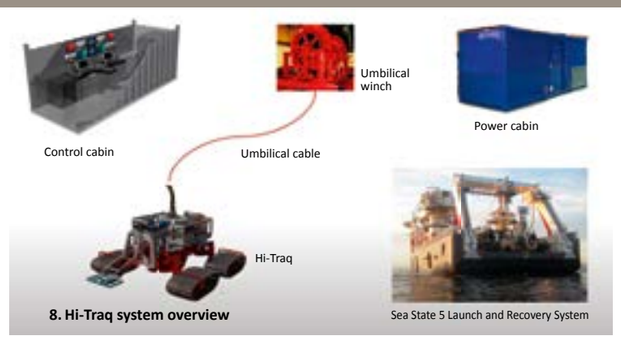
The Hi-Traq has centrally mounted tooling to take advantage of the four-track system. This enables the vehicle to achieve short radius trenching. To solve the challenge of varying soil conditions on offshore wind projects, Hi-Traq can operate three types of tools.

1. A specifically designed jetting tool is used for softer soil types. It comprises multiple jetting chambers with variable pressure settings. Inward-facing jetting nozzles mounted on two jet swords fluidise the seabed to create a trench, and a depressor ensures the product achieves the target burial depth.
2. A cutter chain tool facilitates trenching in harder soils and clays. The cutter chain includes technology co-developed with IHC Dredging & Mining in order to maximise reliability, chain and pick longevity, and performance. The tool, which resembles a large chain saw, has easily interchangeable

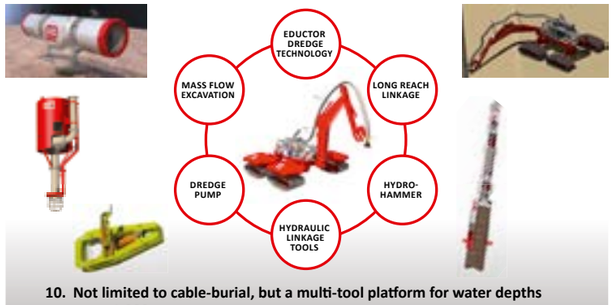
5. The Hi-Traq enables a short trenching radius of 10m, reducing the requirement for second-end operations

7. Interchangeable tool cartridges position the tools in the virtual pivoting point

6. Total X-Y-Z stability at the best conceivable manoeuvrability. Note the vertical tool orientation as the vehicle traverses a slope of 20 degrees



8. Hi-Traq system overview



10. Not limited to cable-burial, but a multi-tool platform for water depths up to 1,000m

9. The containerised control system provides full office comfort and has control positions for two pilots

cutting paddles. This feature serves to accommodate different soil conditions and reduces operational downtime with the fast replacement of worn-out teeth.

3. A rock-cutting wheel is available on the larger variants of the Hi-Traq, which allows trenching in hard rock conditions.

The interchangeable nature of the tools makes the Hi-Traq an extremely flexible piece of equipment. This reduces the risk for wind farm contractors by increasing the capability for trenching in different soil conditions, while also reducing the operational costs of having multiple trenchers on one project. The tools are housed in interchangeable cartridges to ease tool change-out operations (*figure 7*). Each cartridge locks into the chassis by means of mechanical connections, and uses quick release electric and hydraulic energy lines. The tools are electrically or hydraulically driven, dependent on the vehicle size. On-board submersible e-motors drive a submersible HPU, which provides power to the vehicle's hydraulic actuators.

The tool change-out operation, including launch and recovery of the vehicle, can be performed within one normal working shift. This multi-tool vehicle format requires a smaller footprint on a vessel for trenching operations when compared to having multiple systems to accomplish different trenching methods. The interchangeable tool cartridges facilitate quick responses to varying soil conditions.

Two thrusters enable positioning of the vehicle over the product during the deployment stage. A product detection system and product lifters complete the subsea vehicle. Hi-Traq can also be equipped with additional backfilling tools, but these are not always required.

Complete arrangement

IHC EB can provide a Hi-Traq spread as a complete system, including the vehicle, power and control system, umbilical winch and Launch and Recovery System (LARS) (*figure 8*). All but the heaviest Hi-Traq vehicles are deployed and recovered using a lift umbilical, which combines both power and control provision, and lifting strength. The umbilical can also be supplied by IHC, as well as a full control system, providing full office comfort, heating and air conditioning (*figure 9*). The power and control power cabins are standard 20ft ISO containers for ease of mobilisation.

The ergonomically designed control desk provides identical positions for a pilot and an assistant, one doing the major operations and the other on alert, in order to prevent failures of pilots becoming too tired. The touchscreen-operated PLC control system and full video wall display information from the cameras, sensors and sonars mounted on the vehicle.

Last but not least, the arrangement includes a Sea State 5 LARS that may be installed on any vessel of opportunity. This high sea state system fulfils the final design criterion for the Hi-Traq – enlarged operational windows.

Multi-tool platform

The Hi-Traq is not just a trenching vehicle. IHC EB foresees a great future for Hi-Traq as a universal subsea multi-tool platform. Its functions are not restricted to product burial, but the vehicle can also be equipped with a variety of tools for various applications, including seabed survey, de-burial, inspection, repair and maintenance (IRM) and decommissioning operations. This also reveals the strength of the company's integration within the IHC family. A host of proven IHC products is already available for these purposes (*figure 10*) and the Hi-Traq is the centrepiece of a collection of IHC subsea tooling.

The proof of the pudding…

… is in the eating. In spring 2014, Hi-Traq's competence was tested using a demonstration vehicle. Tests were conducted on a specially landscaped track, designed to mimic the worst case permutations found in offshore renewable locations. The vehicle performed well as the illustrations accompanying this article sufficiently demonstrate (*figures 3-6*). In particular, note that the tool remains in a vertical position while traversing the 20° slope, resulting in a stable vertical trench. The vehicle testing can be seen in a promotional film on the IHC YouTube channel.

Conclusion

With the introduction of Hi-Traq, IHC has developed a tool that eliminates the main factors negatively influencing subsea cable burial. The system can contribute to improving the feasibility of offshore renewables by reducing installation costs and project risk. In addition, the vehicle has the capacity to operate in a much wider spectrum of subsea operations, reducing costs for offshore operations. Hi-Traq broadens the scope of mission equipment with which IHC deserves its position as a reliable supplier to the offshore renewable, oil, gas and mining markets.

References

[1] "Pipelaying: IHC Merwede's tower of strength" *IHC Merwede Insight E2*. IHC Merwede, Sliedrecht, The Netherlands, 2013. 8-15

[2] "The first IHC Merwede J-Lay tower". *Ports and Dredging 177*. IHC Merwede, Sliedrecht, The Netherlands, 2011. 32-35

Hi-Traq platforms and particulars

Platform	Power (kW)	Weight in air (mt)	Length (m)	Width (m)	Tooling	Burial depth (m)	Optimised for
J1000	750	24	7	6.5	Jetting	2	Inter-array cables (shallow water jetting platform only)
J1300	1,000	26	7	6.5	Jetting	2	Inter-array cables (shallow water jetting platform only)
M1600	1,200	45	8.4	8.4	Jetting	2	Inter-array cables (hard ground multi-tool platform)
					Chain cutter	2 - 3	
M2100	1,600	65	9.7	8.7	Jetting	3.75	Export cables and pipelines (~16m turning radius)
					Chain cutter	3	
					Cutting wheel	1.5	

EASYDREDGE®: budget-line TSHD range for stock

1. The exterior of the first Easydredge®

Recently, Royal IHC (IHC) took the bold step to build trailing suction hopper dredgers (TSHDs) for stock. The step may break down economic barriers for customers that carry out smaller dredging works. They often operate a few IHC Beaver® cutter suction dredgers (CSDs) – also available from stock – or are entrants to the market. If TSHD operations are required from such contractors, vessel financing and delivery problems can be solved by purchasing or chartering vessels from stock. However, the ultra-short delivery time may also be a big advantage for larger dredging companies.

2. The aft ship is growing on the slipway...

3. ...and also the foreship

4. Similar to the IHC Beaver®, components of the Easydredge® are also standardised and deliverable from stock – this is the HPU

The Easydredge® will come in three sizes, viz. the Easydredge® 1600, 2700 and 3700 (the numbers referring to the hopper capacity). Each model can be executed as either an Easydredge® Port Special, Easydredge® World Dredging, or Easydredge® Marine Aggregates. These distinctions clearly indicate the operations for which they are intended and the appropriate equipment package. More details will be revealed in later issues of *IHC Insight*.

The vessel currently under construction for stock is an Easydredge® 2700 (*figure 1*). It will be supplied with a World Dredging package, which includes bottom doors, a bow coupling and a suction pipe suited for a dredging depth of 25m. This makes her suitable for a wide range of tasks, from the maintenance of ports and channels to land reclamation. The construction is being carried out by IHC partner MTG Dolphin's shipyard (*figures 2-3*), while IHC delivers the design and all major components. The launch is scheduled before the end of 2014, with the delivery set for next summer.

The competitively priced Easydredge® should not be associated with the figurative meaning of the word 'cheap'. On the contrary, she is BV classified for unrestricted navigation and dredging up to 20 miles off shore with unattended machinery space. The dredging installation is of IHC quality, and the navigation and control equipment comply with the operational requirements. She can be navigated by either one or two operators, thanks to an ergonomic control console and simple touchscreen control. The electric and hydraulic installations are basic and reliable.

Competitive pricing has been achieved by thorough standardisation throughout the whole range. Preferred suppliers have embraced this principle. Components have been rationalised, and are interchangeable and repeatedly used over all vessels – such as the bottom doors and their mechanism – while IHC Beaver pumps also serve the purpose of some Easydredge® types. This means that the standardisation of the vessel benefits from the whole of IHC's product portfolio (*figure 4*). No cabling is required on the suction pipe. Propellers, dredge pumps, jet pumps and the four-channel bow thruster are directly diesel-driven.

Consequently, not only is it a competitively priced vessel, but also a very straightforward dredger, easily understandable for the operators and technical staff. It may be a slight exaggeration, but if a person can understand a diesel engine, and basic electrics and hydraulics, he can maintain an Easydredge®.

Notwithstanding the standardisation, rationalisation and 'keep it simple' approach, every Easydredge® is fit for the operations it was designed for. To accommodate future extensions, space, stability and buoyancy have been reserved for standard options, such as jet water on the draghead, spud poles or TDS (Tonnes of Dry Solids) measurement, as well as customer-specific options. Such extensions can be added in the construction stage, but also afterwards, during the lifetime of the vessel, when dictated by particular operations. Flexibility and standardisation are the keywords, not rigidity. More information and specifications are available at *www.easydredge.com*.

Conclusion

By launching the Easydredge® IHC is able to supply any type of TSHD, from the smallest budget-line and mid-range IHC Beagle®, to large vessels following customer specification.

With the first stock TSHD being operational in around eight months, customers can knock on the door and have the ship to start operations immediately. There are more options. For example, she can also be chartered for one-off dredging jobs, or may function as the 'forerunner' while another dredger, which fits the customer's wishes, is purchased and under construction. This means that the dredging company can still make money, while the actual asset is being built. Not simply building a ship, but solving an economic problem – that is the innovation, materialised in Easydredge®.

On order

Yard number	Name	Specifications	Country
TRAILING SUCTION HOPPER DREDGERS			
1274		Easydredge® 2700	For stock
1275	JUN YANG 1	21,000m³	China
1278		5,500m³	South Africa [1]
1279	MAHURY	1,840m³	The Netherlands
STANDARD CUTTER SUCTION DREDGERS			
02811		IHC Beaver® 300SE	Maldives
02806		IHC Beaver® 1200	India
02820		IHC Beaver® 50	Tanzania
02782		IHC Beaver® 65DDSP	Saudi Arabia
SELF-PROPELLED CUTTER SUCTION DREDGER			
CO1276		23,684kW	The Netherlands
PIPELAYING VESSELS			
730	SAPURA ONYX	550t pipelayer	Brazil [2]
731	SEVEN RIO	550t pipelayer	UK
732	SAPURA JADE	550t pipelayer	Brazil
733	SEVEN SUN	550t pipelayer	UK
734		550t pipelayer	Brazil
735		550t pipelayer	UK
-	SAPURA ESMERALDA	300t pipelayer	Brazil
WORK BOAT			
11053		DMC 1450	Tanzania

1

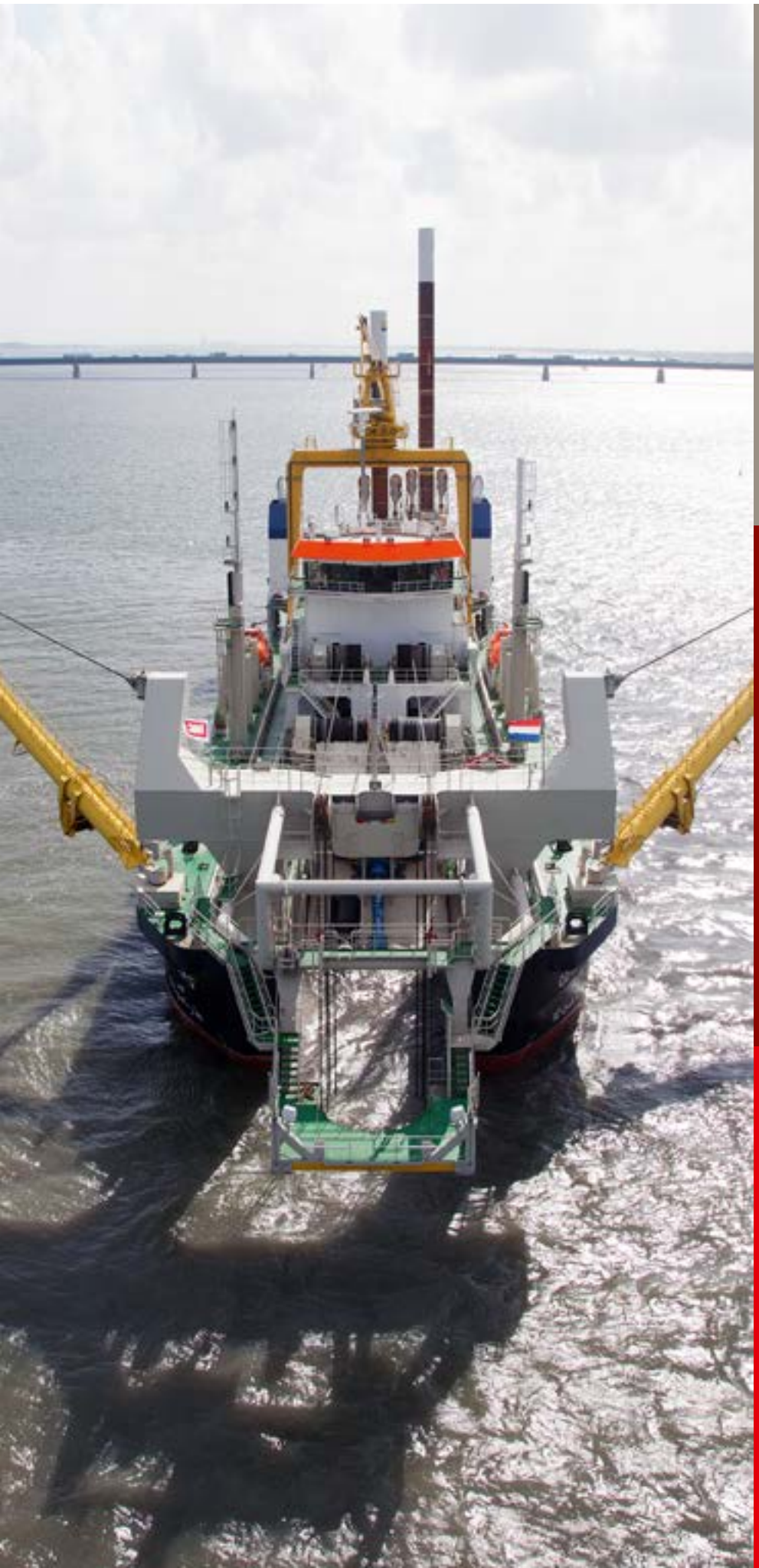
2

3

Recently delivered

Yard number	Name	Specifications	Country
STANDARD CUTTER SUCTION DREDGERS			
02794		IHC Beaver® 45	Bangladesh
02803		IHC Beaver® 50	Saudi Arabia
02804		IHC Beaver® 50	Nigeria
02771		IHC Beaver® 65DDSP	Mexico
02772		IHC Beaver® 65DDSP	Abu Dhabi
SELF-PROPELLED CUTTER SUCTION DREDGER			
02800	AL BAHAR	23,545kW	Saudi Arabia [3]
PIPELAYING VESSELS			
728	SAPURA DIAMANTE	550t pipelayer	Brazil
729	SAPURA TOPAZIO	550t pipelayer	Brazil
WORK BOATS			
11034		DMC1200	Mexico
11052		DMC1400	Saudi Arabia
GRAB HOPPER DREDGER			
11010	ITALENI	750m³	South Africa [4]

4



Main features

- ✓ Integrated pipelaying vessels: Royal IHC gems set sail
- ✓ IHC Systems: innovative training simulators
- ✓ AL BAHAR: a competitive dredger for Saudi Arabia
- ✓ Hi-Traq: award-winning subsea trencher
- ✓ Easydredge®: budget-line dredgers built for stock

Royal IHC (IHC) is focussed on the continuous development of design and construction activities for the specialist maritime sector. It is the global market leader for efficient dredging and mining vessels and equipment – with vast experience accumulated over decades – and a reliable supplier of innovative ships and supplies for offshore construction.

IHC has in-house expertise for engineering and manufacturing integrated standard and custom-built vessels, advanced equipment and also providing life-cycle support. This integrated systematic approach has helped to develop optimum product performance and long-term business partnerships. The company's broad customer base includes dredging operators, oil and gas corporations, offshore contractors and government authorities.

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