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Beijing – P.R. of China
New Delhi – India
St. Petersburg – Russia

Regional IHC Organizations worldwide
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Kinderdijk – The Netherlands
Lagos – Nigeria
Mumbai – India
Singapore – Republic of Singapore
Tianjin/Tanggu & Guangzhou – P.R. of China

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IHC Systems
Dedicated to Efficient Dredging

Dynamic Positioning &
Dynamic Tracking System
(DP/DT)

The technology innovator.
‘Efficient Dredging’ helps contractors to make the most of their dredging equipment: to generate high economic and ecological benefits, achieve optimal utilisation rates, reduce dredging time, make the dredging process smoother, simplify fault diagnosis, reduce downtime and wear, prevent under- and over-dredging, and maximise crew satisfaction.

Even after a shipbuilder has built reliable and efficient equipment, and even after contractors have optimised equipment utilisation, the Efficient Dredging concept continues to make a significant contribution, providing dredgers with extra ‘senses’ and ‘hands & feet’.

Relatively modest investments in instrumentation, automation, surveying and simulation techniques produce major improvements in efficiency and accuracy. Automation under dredge master supervision can enhance production by up to 30%.

IHC Systems draws on all kinds of conventional and innovative control, automation, communication and presentation technologies. We also make the most of the knowledge and resources of the entire IHC Merwede group.

The concept is honed in close alliances with contractors and worked out in specific products, systems and services for every category of dredger and in every field. The products can cope with all dredging and mining conditions.

Our knowledge, expertise and experience are dedicated to reducing over-dredging, spillage, energy consumption, emissions, turbidity, ecological side-effects and operational costs. They represent our contribution to a sustainable future for all our stakeholders.

...our contribution to a sustainable future
Introduction.

Dredging and Offshore activities have many goals: creating and maintaining proper waterways, reclaiming land, winning and transporting raw materials, and laying and protecting vital energy and communication lines. Ports, hinterland and shore landings make up an intricate infrastructure that is closely interwoven with the structures on the seafloor. Specialised working vessels play an essential role in this world.

Physically speaking, this all involves removing soil and rock, digging trenches, laying cables and pipes, drilling holes and positioning heavy equipment on the seafloor. In most cases, extreme precision is required, against a background of severe operational restrictions caused by tight schedules and limited sea-state windows. So Dynamic Position & Dynamic Tracking (DP/DT) systems are a major benefit for these operations. Generally, they allow working vessels to maintain position, course and track accurately, much longer and more reliably than manually operated vessels. Indeed, some operations just wouldn’t be possible otherwise. In most cases, the systems also considerably enhance safety and help to reduce fuel consumption and emissions.

The core of DT/DP on specialised working vessels is the triple dynamic relationship between the vessel, the vessel-seafloor connection, and external forces. This is particularly true in the extreme variation of forces generated by the draghead and the suction pipe on trailing suction hopper dredgers (TSHD), which easily confuse the vessels’ power sharing gear. IHC Systems DP/DT systems are primarily used on modern TSHDs. They also are successfully applied on multifunctional offshore vessels like rock placement vessels, and can easily be used on pipe-laying, diving support or drilling vessels.

The modular arrangement allows for fully regulation-compliant DP0, DP1 and DP2 systems – but also for tailor-made compact versions. Operators can receive training in IHC Systems’ training simulator.

Benefits

Dredging and Offshore activities have many goals: creating and maintaining proper waterways, reclaiming land, winning and transporting raw materials, and laying and protecting vital energy and communication lines. Ports, hinterland and shore landings make up an intricate infrastructure that is closely interwoven with the structures on the seafloor. Specialised working vessels play an essential role in this world.

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IHC Systems’ DP/DT systems stand out from the competition. Their distinctive features include:

- Outstanding human-machine interface (HMI) for intuitive control that is highly appreciated by operators.
- Superb transition from manual to automatic and combined modes and vice-versa.
- Patented and accurate estimates of the extreme variations in the forces exerted by the draghead and the suction pipe. For about two decades now, the systems have proven to be reliable performers on ‘missions impossible’: keeping dredging TSHDs on course and track accurately.
- Sophisticated inertia-compensated speed control.
- Embedded, type-approved, high speed heading and track control, replacing the usual autopilots.
- Plug and play characteristics facilitate extremely short commissioning time.
A typical DP/DT system

A typical IHC Systems DP 0-1/DT system draws on proven and/or certified industrial and marine-tailored hardware. It comprises:

- A certified and proven industrial programmable logic controller (PLC) with distributed I/O for processing signals to and from actuators.
- A rugged, marine-tailored, certified personal computer (PC) at the heart of the DP/DT system, communicating with the PLC and human-machine interface (HMI) equipment. Serial ports for NMEA links as required by DGPS, gyro compasses, ECDIS, etc. are also linked to the PC.
- HMI equipment comprising:
  - Certified IHC Systems dedicated DP/DT operator panel
  - Certified joystick and trackball
  - Certified 19" conning display, providing access to a number of colour video pages for any specific operational mode, and to the advanced functions and settings of the system.

Optional systems can also be geared up:

- Additional working station, consisting of a PC and HMI equipment for mounting in a wing navigation console, for example.
- ECDIS or IHC Systems Dredge Track Presentation System (DTPS).
- Wired or wireless remote control panel that can be used as a mobile wing console. It comes in two versions: (1) remote joystick DP control or (2) manual actuator control.
- Independent joystick system for compliance with the relevant required regulations.
- Additional control levers for bow thrusters, rudders etc.

The DP/DT software includes the familiar hydro-mechanical models. The model-based control software also incorporates extended Kalman filter modules. These Kalman filters are also used for dead reckoning assistance during DGPS failure. A patented algorithm accurately estimates and processes the widely varying forces exerted by the draghead and the suction pipe. Embedded and type-approved track control software provides track control functions, including inertia-compensated high-speed autopilot and track control. The software is dongle protected against unauthorised use.
The operational modes are tailored to specific operational challenges. In outline, they are:

1. **Transit (Manual Mode via DP/DT)**
   - DP/DT system switched on.
   - Control of vessel movement with the normal propulsion control levers, steering wheel and bow thruster control lever.

2. **Sail Pilot (Adaptive high-speed Autopilot)**
   - For sailing longer distances with a minimum speed of 5 knots.
   - Automatic heading control.
   - Speed is controlled manually or automatically according to operator preference. Bow and stern thrusters are idle.

3. **DT-Sail (Adaptive High-Speed Track Pilot)**
   - For sailing planned longer distances by controlling track at a given ground speed of at least 5 knots. Advanced inertia-compensated alternative to the standard autopilot. Adaptive controllers automatically tune to vessel’s manoeuvring properties and speed and to wave conditions. Speed is controlled manually or automatically according to operator preference. Bow and stern thrusters are idle.

4. **Medium Pilot (Autopilot with dredge force compensation)**
   - Maintains the heading of a TSHD while dredging at speeds of 2-5 knots. Ground speed and heading are maintained automatically using easily operator-adjustable set points. Bow and stern thrusters are used.

5. **DT-Medium (Track Pilot with dredge force compensation)**
   - Automatically sails tracks while dredging for bringing an area or a trench to specified depth.
   - Compensates for dredging forces at speeds of 2-5 knots.
   - Bow and stern thrusters are used. Vessel is steered along track by changing the heading drift angle, reducing bow thruster power consumption. Facilitates interactive removal of prominences.

6. **DT-Slow (Track Pilot with selectable heading)**
   - Maintains ground speed and optimal heading/auto heading/drift angle according to operator preference when, for example, dumping soil via the bottom doors, sailing over a track in very narrow waters, dredging trenches etc. Bow and stern thrusters improve heading control at speeds of -2.5 — +2.5 knots.

7. **DP Joystick Position Control**
   - A user-friendly way to change position and heading when vessel speed is close to zero. Control with individual thruster levers is replaced by control with a single joystick. Uses the DP allocation algorithm to generate rpm, rudder/azimuth angle and propeller pitch values to realise surge, sway and heading motions.

8. **DP-Auto (Dynamic Positioning)**
   - Accurate maintenance or change of position and heading at vessel speeds close to zero. Automatic control of surge, sway and heading motions. Dead reckoning assistance during DGPS failure — as in all other automatic modes. Energy-saving weather vane modus can be selected.

9. **Optional functions**
   - **Anchor Assist Mooring:** maintains mooring positions at strong winds and currents.
   - **DP-Follow:** maintains a moving DP position that follows an ROV, for example.
   - **Remote joystick control offers the functionality of items 7 and 8 with full freedom for the operator during DP or docking operations. Eliminates the need for bridge wing panels.**
Human-Machine Interface (HMI)

The IHC Systems HMI was designed after intensive theoretical and practical analysis of rules, ergonomical laws and operator interviews about safe and intuitive control. As a result, it is one of the best DP/DT HMIs in the world. It continuously enhances safety and intuitive operation and results in genuine operator satisfaction. Operators never have doubts about whether a function is online or offline: they can switch in all circumstances between manual, automatic or combined manual/automatic modes in a bumpless way, easily and intuitively. The HMI’s heart is the combination of a certified conning display with dedicated screen pages and a certified operator panel. This combination is accompanied by a tailored 3D joystick for the single-handed manual control of surge, sway and heading based on the DP/DT allocation algorithms.

Operator panel
The operator panel is arranged in clear and distinct functional blocks for mode and conning page selection, transit-related functions, heading functions, position functions and general functions. It includes:
- Turning knobs for heading angle, track offset and groundspeed set points.
- Push-button/LED indicators for the intuitive allocation of relevant movements or actuators to the appropriate manual control apparatus or automatic routine.
- Short-cut push-button/LED indicators for the dominant operational modes, which combine or block actuator and control element allocations as appropriate.
- Push buttons for conning page selection.
  General functions: lamp dimmer, alarms, ready for service lamp, remote switch-over, etc.

Conning display
The certified conning display/mouse/trackball arrangement and its independent optional repeaters all feature:
- 8 main conning pages which are easily displayed using the shortcut buttons on the operator panel, each dedicated to the current operational mode, providing no more and no less information than that mode requires. However, operators can switch pages freely and easily as they prefer at any stage of any operation using the page selection buttons on the operator panel or with a click of the mouse.
- Auxiliary pages for the selection of rudder control preference, permissible and forbidden sector settings for azimuth thrusters and optimal heading (weather vane) search, pivot point determination for DP and DT etc.
- Waypoint pages for the DT modes, processing waypoints generated by ECDIS or IHC Systems DTPS, and for maintaining a shifted track.
- Online DP capability plots, showing current, wind and thruster power limits.
- Acoustic warnings for vital system actions, such as switching to manual after expiry of the time span allowed for dead reckoning.
- Daylight and nighttime display colour schemes.
- Setting and verification pages for connected reference systems, sensors, alarm pages etc.
- Training page that facilitates operator training any time the system is not operational, drawing on ‘soft’ navigation console and operator panel simulation. Interference with actual actuators is blocked.
Equipment geared to performance

DP/DT systems work in conjunction with an array of other equipment on board, and so that equipment has to be in place and operational. The vessel herself and her power systems must also be adequate to process DP/DT commands promptly in order to make the most of DP/DT.

In many cases, with new vessels automated from scratch, these conditions can be met without difficulty. In other cases, for instance during retrofits, IHC Systems will conduct the relevant feasibility studies and it can deliver all the equipment needed. In the case of a real project, customers will receive fully detailed specifications and an extensive questionnaire in order to fully tune the DP/DT system to the vessel’s machinery and DP capability.

Obligatory connected equipment

IHC Systems DP/DT has extensive software tools to match NMEA and other serial formats. The exact number of obligatory reference systems to be connected depends on the DP class notation and other regulations. The following is a summary of equipment that must be connected and compatible with the DP/DT basic system (DP1 between brackets) as a minimum:

- 2 (3) DGPS position reference systems
- 1 (2) gyrocompasses or equivalent heading reference systems
- 1 (2) wind sensors
- 1 (2) motion reference units (pitch, roll and heave)
- Draghead differential pressure and pipe angle measurements for the estimation of trailing forces – or, alternatively, force and angle measurements in pipe-lay spreads, drilling pipes etc.
- Relevant I/O of the vessel’s power system (sometimes already available in a PLC network)
- Comprehensive I/O of main thrusters, azimuth thrusters, tunnel thrusters, rudders and their control systems (sometimes already available in the vessel’s PLC network).

Connectable equipment for specific options

- Pipe force measurements for high-accuracy (offshore-related) DT operations
- Winch force measurements for any winch used in Anchor Assist Mooring mode
- Acoustic target position measurement (USBL, SSBL (HiPAP), SBL or LBL) or short range relative position finder (RADIUS) to be applied for Follow Target Mode or as an independent additional position reference system for DP2 notation systems
- Full duplex radio telemetry unit for wireless remote control

Connectable equipment for enhanced ease of operation and/or performance

- ECDIS: Electronic Chart Display and Information System (offline and online track planning)
- IHC Systems Dredge Track Presentation System (offline and online track planning, pre-information about work area and dredged depth feedback)
- Speed log