

# Ship Building industry

## Audacia

PIPE DREAM COMES TRUE

## Dolfijn

PRIDE OF THE DUTCH MUSSEL FLEET

## Seven Oceans

SHOWCASE OF DUTCH KNOWHOW

## Surveyor 1 & 2

GREEN TECH VESSELS

MAGAZINE FOR THE SHIPBUILDING, SHIP MAINTENANCE AND SHIP REPAIR INDUSTRY

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SHIP REFIT, REPAIR & CONVERSION

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# ***Audacia***

## Next Generation Pipelay Vessel



**AUDACIA**

BUILDERS  
OWNERS

Keppel Verolme  
Allseas Group S.A.



*Pipe-laying vessels used to have their “stinger” astern: a long protruding beam that guides the pipeline to the sea bottom. That’s why conventional pipe-laying vessels move forward when laying a pipeline. A logical concept, as this is the direction of movement the ship has been designed for. However, in case of a ship conversion, the design requires the complete removal of the ship’s stern and thus of the original propulsion system. That’s why Edward Heerema - owner and president of Swiss-based pipelay contractor Allseas - had a brilliant idea: build the stinger on the bow. Backward pipe-laying, a new groundbreaking trend in deepwater pipe-laying?*

*Text by ir. Frans Zuurveen and photography by Dennis Vinkoert.*

Late this summer Allseas’ new pipelay vessel Audacia will be put into service. The high tech conversion job from a bulk carrier to a dedicated pipelay vessel has been carried out at the Dutch shipyard Keppel Verolme. Allseas currently operates five vessels: the DP pipelay vessels Lorelay and Solitaire, the shallow water pipelay vessel Tog Mor, the DP trenching support and subsea installation vessel Calamity Jane and the DP ROV/survey support vessel Manta.

Audacia is 225 m long, which in terms of size places her between Allseas’ DP pipelay vessels Lorelay and Solitaire. She is suited for installation of pipelines up to a diameter of 60 inches including coating, and is intended for operation in all water depths. The concept of Audacia has been developed entirely in-house by Allseas. The 106 meter long stinger is located at the bow, which distinguish her from her sisters, Solitaire and Lorelay. As a consequence, the main propulsion system of the converted Panamax bulk carrier is still

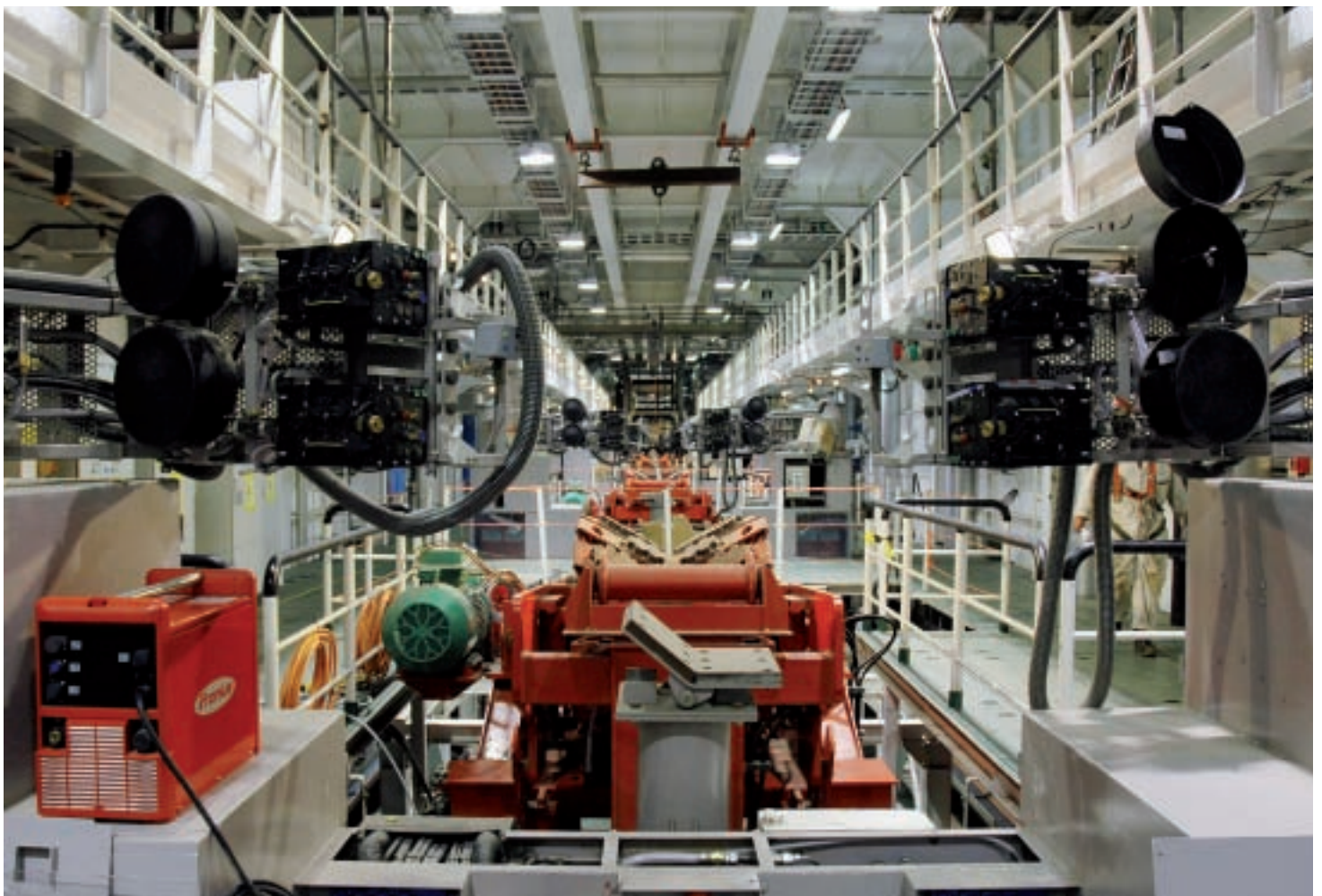
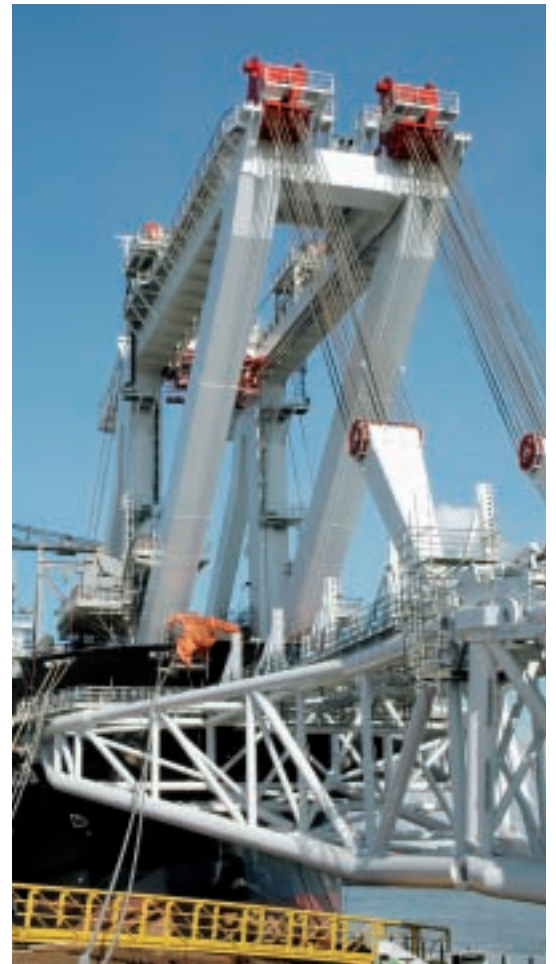
intact. The high sailing speed of 16 knots with the existing propulsion system makes her extremely suitable for fast mobilizations to remote areas.

### Conversion

A stinger on the bow makes it possible for the rebuilt ship to retain its original stern with propellers, shafts and gearboxes, allowing the ship to steam to the next pipe-laying location at its full speed. By contrast, pipe-laying vessels with their stinger astern must depend on their azimuth propellers, and are consequently able to achieve only much lower speeds.

The successful ship conversion took place at Keppel Verolme’s shipyard in Rozenburg near Rotterdam, where the Panamax bulk carrier Geeview was transformed into the sophisticated pipelay vessel Audacia. The project involved an investment of nearly three hundred million euros. This year three of Allseas’ pipe laying vessels will start laying gas pipelines in the







Bay of Bengal with a total length of 313 km at a depth up to 1,200 meters. Audacia will start here together with the pipe laying vessels Lorelay and Tog Mor.

### Floating Pipe-Welding Factory

The Allseas Group SA, founded in 1985, is one of the major offshore pipelay and subsea construction companies in the world. The company already owns the world's largest pipe-laying vessel Solitaire, which, like another of its ships, Lorelay, is equipped with a highly advanced dynamic positioning system, which enables pipe-laying without the use of anchors. Both Solitaire and Lorelay are deepwater pipe-laying vessels. Shallow water operations are reserved for pipelay barge Tog Mor. Other Allseas ships are the trenching and subsea support vessels Calamity Jane and Manta. All three pipe-laying ships operate with Allseas' completely automatic, in-house developed welding system Phoenix. Latest news: at the end of 2010, Allseas' platform installation/decommissioning and pipelay vessel Pieter Schelte will come into service. With a length of 360 m and a width of 117 m, this will be the largest work vessel that has ever been built in the world.

The enormous bulkcarrier space of Audacia is fully utilized to stock a large number of pipes with standard lengths of 12 m in many varieties, up to a maximum diameter of 60-inches. Moreover, the vessel accommodates the welding machines as well as the welded pipeline, which takes up a considerable part of the ship's length, not to mention the 106 m long stinger.

Allseas bought the Chinese-built 74,000 dwt bulk carrier Geeview two years ago. With its dimensions of 225 m length and 32 m width and at a draught of 8 m, the hull of this Panamax type ship easily accommodates a complete pipe-welding factory with stock space and cranes. Thanks to the stinger at the bow, the original propulsion system was kept intact, so that the two original propellers and diesel engines now give Audacia a relatively high speed of 16 knots. Formally, Allseas' daughter company Société de l' Exploitation du Audacia is the owner of the new pipe-laying vessel. The name Audacia has been derived from the Latin term 'audacious' which means heroic and unafraid in English.

### Dynamic Positioning

Imtech Marine & Offshore put all efforts to realize the complete technical installations aboard Audacia, according to the concepts and specifications drafted by Allseas' design team. The project took 300,000 man-hours and was accomplished within less than two years. The project included the dynamic positioning (DP) propulsion system with automatic speed and position control, all navigation and communication systems and the complete wiring and cabling. Connection plans established the type, separation, route, length and disassembly of approximately 8,000 cable parts with a total length of 400 km.

Designing, constructing and testing the DP system was extremely challenging. The system positions the ship exactly at one point with regard to the sea bottom





as a pipeline runs through the welding system. When the pipeline goes into the sea, the DP system guides the vessel periodically backwards across the length of one pipe section. The DP system can also be switched off, whereupon the original bridge takes over the navigation. The system as a whole can be subdivided into position finding and ship propulsion.

Wind and stream cooperate to move the vessel out of its position. For position defining, four reference systems are in use: Differential Global Positioning System (DGPS), radar (only if there exists a fixed reference point nearby), HiPap (operating through sound signals from beacons on the sea bottom), and Tautwire (detecting ship movements by a tightly stretched cable fixed to a heavy weight on the sea bottom). When a slight deviation from the required position (or speed or direction) is detected, the position control system activates the propulsion system, which brings about a correction. Due to the control system, the vessel accurately follows a preprogrammed pipeline path on the sea bottom, with or without a precut trench. Audacia has the capacity to lay 10 km of pipeline in one day, and can work at depths up to a maximum of 3000 meters.

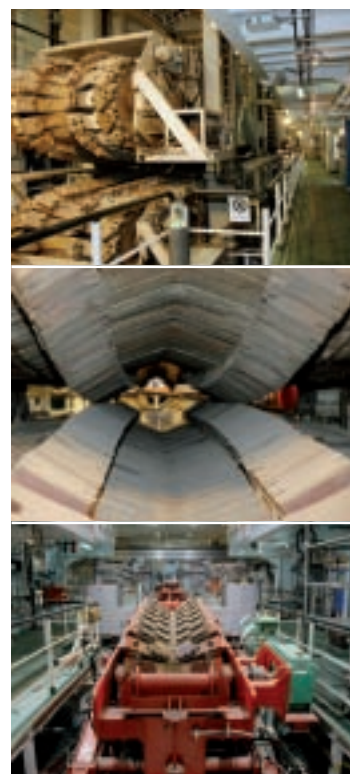
With regard to additional marine electronics and automation, hardware including satellite and terrestrial broadcast receivers, DVD and video players, monitoring and audiovisual equipment were supplied by Radio Holland Netherlands, while SARC supplied the LOCOPIAS loading and damage evaluation computer software for the Audacia. The software

provides exact calculation of each loading condition ensuring maximum safety of the vessel, the crew and the environment and an optimal loading of the vessel.

### DP Propulsion System

The original propulsion plant of the vessel has been maintained. Audacia has a main propulsion power of 10,500 kW resulting in a cruising speed of 16 knots. Two new engine rooms were created for the powering of the dynamic positioning system. Each engine room accommodates three 5,850 kW Wärtsilä FS3500 marine diesel engines. The pipe-laying propulsion system consists of six 5,000 kW retractable azimuth thrusters, each with 80 metric tons bollard pull. The thrusters correct the ship's position by adapting their individual speed or direction. They are retractable to reduce resistance when operating in normal sailing mode. Imtech Marine & Offshore and Finnish power specialist Wärtsilä Corporation cooperated in a consortium to design and realize the DP propulsion system. Each thruster includes a reduction gearbox, electric motor (3000 V, 5000 kW), frequency converter and speed controller.

The power package delivered by the Imtech Wärtsilä consortium comprises six diesel generators (11 kV, 8,000 kVA). They are connected to two main switchboards supplied by Imtech Marine & Offshore. Imtech also provided ten transformers: six for the electrical power and four to supply energy to cranes, welding machines and lighting. Three 3 MVA transformers feed the other cranes and the pipe-laying



systems. The bulk carrier's original engine room has been preserved, and two new engine rooms have been added. These are completely equipped to supply power for the pipe-laying installation and the DP system.

The connecting element between all systems is the Imtech integrated automation system operating "from the diesel generator-set to the thrusters". It also regulates the power balance. Because the thrusters use a great deal of power, fine tuning of the power distribution is essential in connection with the energy needed for the pipe-laying installation. The DP system is also part of the integrated automation system. For building the complete electrical infrastructure, Imtech contracted the GTI Suez Group. Audacia is the first pipe-laying vessel, which is classed as a LR Mobile Offshore Unit and has a DP(AAA) notation.

## Stinger & Handling Frame

Striking features of the vessel are the pipelay stinger and the stinger handling frame that suspends the 106 meter stinger over the vessel's bow leaving the aft ship intact, thus allowing the vessel to maintain its bulk carrier speed. The stinger tip can be lifted to a height of 40 meters above sea level to avoid impact with the water in extreme weather conditions. The stinger with a length of 106 m is a kind of chute featuring an open-lattice gantry construction, guiding the pipeline into the water. The structure of the stinger consists of three sections and has a total steel weight of 770 metric tons. A roller system on the stinger guides the welded, vulnerable pipeline in a curvature that prevents buckling. Eventually the stinger directs the pipeline vertically to descend carefully to the sea bottom. The stinger is strong and rigid enough to carry a maximum of 3,000 m pipeline length.

The mechanical and structural design of the stinger handling frame was carried out by GustoMSC and included the stinger hinges, the stinger handling frame including overhead trolley crane and stinger hoist

system. GustoMSC supported Allseas with engineering services from start of concept design to the end of basic design for Audacia.

Engineering work on the stinger handling frame included concept design, where different concepts were compared and the overall layout selected. During basic design, structural analysis of the stinger handling frame was carried out with the aid of the Finite Element Method (FEM), all in compliance with the regulations of Lloyd's Register. The analysis included design of the frame itself and overall analysis of the complete system of frame and vessel structure. The latter was based on full dynamic loads from wave motion analysis including stinger and pipelay loads.

The stinger handling frame is a structure integrated in the vessel supporting the stinger with a wire system. The frame consists of four compression members consisting of two legs and two struts, four tension members (two tie down members and two horizontal girders), and two transverse girders. The overall dimensions of the stinger handling frame above main deck are approximately 57 meters long, 13 meters wide, and 27 meters high. The frame is integrated in the vessel's bow structure with inclined firing line ramp and integrated in the new firing line shelter.

Two crane tracks supporting an overhead trolley are on the inner side of the horizontal girders. The winches are situated on foundations connected to the outer sides of both legs. To counteract possible uplift and to prevent slack-wire conditions two flippers were designed.

In addition to the engineering work on the stinger handling frame GustoMSC also carried out:

- naval engineering work such as vessel arrangement and motion analysis work;
- structural engineering related to the bow ramp modification, engine rooms and superstructure including the firing line shelter located on the centerline;





Photo courtesy Allseas

- new marine systems such as bilge system, sea water and fresh water cooling systems.

### Firing Line

Audacia is provided with two pipe transfer cranes, four pipe storage holds with each one transfer overhead crane, and one transfer overhead crane over the hatch on main deck. In the “firing line” the pipes are assembled, welded, tested and coated. The firing line runs from the stern to the bow of the vessel and is situated on the vessel’s center line. The line includes eight welding stations, an x-ray testing station, two pipe-coating stations and three tensioning stations. During pipelaying, the three 175 t tensioners keep the pipeline under tension to prevent pipeline buckling. Buckling may occur at the point where the pipeline leaves the stinger or when the pipeline touches the seabed and is caused by excessive bending in the pipeline. The tensioners clamp the pipe with crawlers that roll fully controlled whilst the vessel is making a movement. The weight of the pipe and the depth of the water dictate the degree of tension: more weight and/or deeper water mean more tension.



### Abandonment & Recovery

Audacia features two abandonment and recovery (A&R) winches with a joint capacity of 550 tons. The A&R winches are used to lay down and pick up the pipeline on the seabed. Rough weather may prevent the DP system from doing its work properly, forcing the vessel to head for a safe harbor, which means that the partly finished pipeline must be abandoned. The pipeline is then closed at the end with a plug connected to a heavy steel cable. The A&R-winches use the cable to lay the pipeline onto the sea bottom. The A&R-

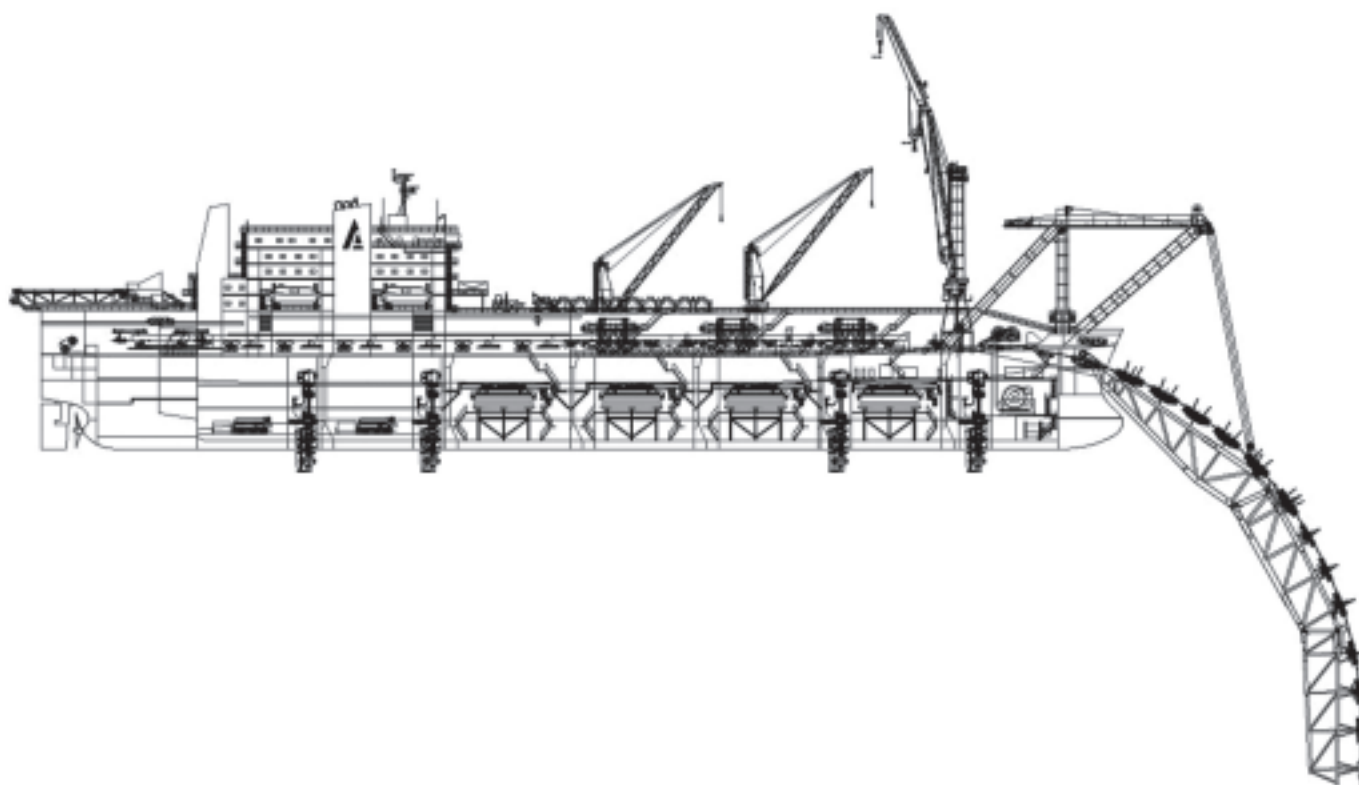
winches take over the power from the tensioners and make sure that the correct tension is carefully maintained on the pipeline preventing pipe rupture. Once this has been accomplished, a buoy indicates the position of the unfinished pipeline so that the A&R-winches can pick up the pipeline to proceed pipe laying. The frequency converters for both the tensioners and the A&R winches come from Imtech Marine & Offshore. Van Mechelen Lifting Gear supplied all wire rope sheaves for the A&R-winch, the stinger handling system, and the A-frame lifting system.

### Accommodation

Allseas contracted Hertel Marine Services to deliver the entire personnel accommodation unit, including the steel construction work. Hertel and subcontractor Genius Vos built a 2,600 ton unit that resembled a complete apartment building in steel. Completely furnished and ready for use immediately following installation, the module incorporates all the facilities required, including living rooms, air conditioning, sanitary units, fitness rooms, sauna, and provisions for cooking and catering.

Adaptions in the engine rooms’ machinery sections include the extension of the existing steam boiler plant, including one oil-fired steam boiler, feed water tank and pumps, and heat exchangers by Aalborg Industries BV. Technisch Bureau Uittenbogaart BV supplied the Deerberg waste management system, sliding and fire doors, and tank vent check valves. Last but not least, Ned-Deck Marine and Viking Life-Saving Equipment provided six life boat davits and 90-person life boats, life rafts, a rescue boat and a comprehensive range of life-saving equipment.





## Facts & Figures Audacia

### Principal particulars

Length overall including stinger	327.00 m
Length overall excluding stinger	225.00 m
Stinger length	106.00 m
Length between perpendiculars	217.00 m
Breadth	32.26 m
Depth to main deck	19.20 m
Draught, excluding thrusters	9.00 m
Accommodation	240 persons

### Installed power

Total installed	35,100 kW
Main propulsion power	10,500 kW
Cruising speed	16 knots

Welding stations	8
Tension capacity	525 t (3 x 175 t)
Maximum pipe diameter	60 inches
Pipe storage capacity (in hold)	16,000 t
DP System	NMD Class 3

### Main Suppliers & Subcontractors

**De Boer Staal** Steel plates and profiles | **Corrosion & Water-Control** Cathodic protection for stinger | **Genius Vos** Steel sections | **GTI** Engineering & installation electrical infrastructure | **Gusto MSC** Concept and basic design engineering work | **Harold** Living quarters | **Hertel Marine Services** Complete accommodation unit | **Imtech Marine & Offshore** Engineering & installation electrical infrastructure, power generation, propulsion package, UniMACS 3000 integrated bridge system | **International Paint** International® marine coatings for holds engine rooms, ballast tanks | **Iv-Bouw & Industrie** Construction drawings | **Johnson Controls** HVAC systems | **Kongsberg Maritime Ship Systems** Kongsberg Simrad DP3 system | **Lloyd's Register of Shipping** Classification | **MAN Rollo** Emergency generator set | **Van Mechelen Lifting Gear** All wire rope sheaves stinger handling system, A&R and A-frame lifting system | **Mercon Steel Structures** Building stinger | **Ned-Deck Marine** Lifeboat davits, rescueboat with davit and raft davits | **Nexans** Electric cables | **Northrop Grumman** Sperry Marine BridgeMaster E dual channel radar system, NAVCOM system | **Observator Instruments** Hepworth windshield wipers | **Qua-Vac** Sewage treatment installation | **Radio Holland Netherlands** Satellite TV antenna, TV and radio distribution system, custom-built head-end equipment racks, audiovisual equipment | **Reikon** Azcue pumps | **SARC** Locopias loading computer software incl. intact stability, longitudinal strenght, interface to the tank gauge system and some ship-specific modules | **Theunissen** Zenitel communication equipment, **Aqua Signal** Lighting, MCT Brattberg cable transit seals, SeaTeleCom communication equipment | **Viking Life Saving Equipment** Lifeboats, davits, rescueboat with davit and raft davits | **VULKAN-DMR** Elastic mountings | **Wärtsilä Nederland** Wärtsilä 9L38B main engines | **Wärtsilä Propulsion Netherlands** Retractable Azimuth thruster units | **Westfalia** Fuel- and lube oil separators, visco booster units

**i.** [www.allseas.com](http://www.allseas.com)