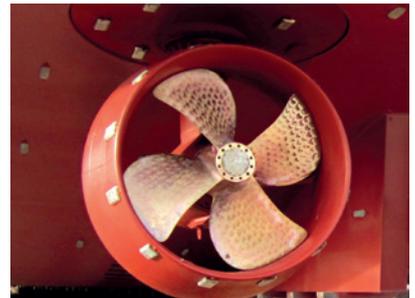




TECHNOLOGY INFORMATION



 **Steerprop**
The Azimuth Propulsion Company

STEERPROP PROPULSION

ELECTRIC STEERING

Steerprop Azimuth propulsors are equipped with **robust electric steering gear**. Electric motors controlled by frequency converters produce the azimuthing torque.

Energy-efficient and accurate electrical steering has constant steering speed. Using power only when actively turning, it produces significantly **less noise** than hydraulic steering systems. The mechanically simple but high quality construction is **durable** and the service is easy.

PRESSURIZED LUBRICATION SYSTEM

Smaller Steerprop propulsors utilize both **pressurized and immersion lubrication**. Gears and bearings in upper gearbox are lubricated with pressurized oil jets, while components in lower gearbox are immersed in oil.

Larger Steerprop propulsors are **pressure lubricated** in both gear sets. As superfluous oil from gearboxes is moved into the oil tank, no extra energy is consumed by oil churning by gear wheels.

Utilizing pressure lubrication in both gearboxes also reduces the amount of lubrication oil required.

OPTIMIZED STEEL STRUCTURE

Cast steel housing is used for maximally optimized propulsor body shape and weight. It is especially suitable for larger propulsor sizes and stringent ice classes.

High-precision **fabricated steel** is used for smaller Steerprop propulsors.

SEALS

Steering and propeller shaft seals are optimized for each Steerprop propulsor type. For example, steering tube equipped with three lip seals forming pressurized oil chambers connected to propeller shaft seal enable the bleeding & flushing of the entire seal system.

An example of **Steerprop propeller shaft seal** is a quadruple ring-type lip seal with oil chambers pressurized by seal oil tank. The tank is equipped with instrumentation for seal system condition monitoring. Larger Steerprop propulsors shaft seals use pressurized air to eliminate even the smallest seal oil leaks.

HIGH PERFORMANCE NOZZLE

Steerprop Ducted Propulsors are equipped with Steerprop-designed **high performance HJ3 & HJ4 nozzles**. They provide a 5-6 % improvement in **bollard pull** and improve **free running efficiency** by 10-15 % in comparison to standard nozzles.



BASIC FEATURES



For maximal reliability, Steerprop Azimuth propulsor design is kept **mechanically simple** and the amount of components that may wear in use at minimum.

Reliable propulsors need less maintenance and result in **less downtime for service**. Mechanical simplicity also makes any required service operations quicker and requiring less spare parts.

All joints in power train are **conical or cylindrical shrink-fit joints**. There are no keyways to deteriorate the integrity of power train shafts, bearings or gears.

Only high quality components from well-known, reputable manufacturers are used in Steerprop Azimuth Propulsors. Manufacturers of the most critical components are carefully **scrutinized on personal visits**.

All components used in Steerprop Propulsor power train conform to the **highest standards of quality and reliability** and are always classified by established classification societies.

Steerprop Azimuth Propulsors and their auxiliary equipment are designed to be **as compact as possible**, enabling the propulsors to be used in vessels with low main decks or otherwise critical space factors.

The **modular structure of auxiliary equipment** enables fitting the equipment also to small propulsion rooms.

Steerprop Azimuth Propulsors are engineered with a **fail-safe sequential strength security principle** for both the power train and the housings. The cheapest and most easily replaceable parts are designed to be the weakest.

In power transmission, propeller blades are the most easily replaceable parts, where as the more valuable and harder to service parts are safely protected inside the propulsor body.

Safety is emphasized within the over-all strength of the housing structures. In case of an overwhelming impact, e.g. hard grounding, the bolted flange between propulsors lower housing and upper parts is designed to break off in a controlled manner.

**ROBUST
MECHANICAL
CONSTRUCTION**

**KEYLESS
SHRINK-FIT
JOINTS**

**HIGH QUALITY
COMPONENTS**

**COMPACT
PROPULSOR
SIZE**

**SEQUENTIAL
STRENGTH**

STEERPROP PUSH-PULL CONTRA-ROTATING PROPELLERS (CRP)

Steerprop CRP propulsors combine the advantages of a pulling propeller with the benefits of dual-end push-pull CRP technology. With various efficiency enhancing solutions in a robust mechanical structure, Steerprop CRP's offer unsurpassed propulsive efficiency and reliability even in the most demanding operating conditions.

FEATURES AND ADVANTAGES

- o Independent pulling and pushing propeller
 - o Benefits of pulling propeller
 - o Two propellers almost double propeller disc area
 - o Optimal power distribution
 - o 60 % pulling, 40 % pushing propeller
 - o Lower mechanical load on components
 - o Ice-classification without compromising efficiency
 - o Larger, slower propellers
 - o Load distribution enables larger & slower propellers for greatly enhanced efficiency
 - o Low noise
 - o Low cavitation
 - o Hydrodynamic optimization
 - o Positive hydrodynamic interaction between front propeller & propulsor body
 - o Rear propeller clear of front propeller's tip vortex
 - o Rotational energy recovery with CRP effect further improves the efficiency
 - o Unique intensified slipstream beneficial in ice-management operation
- o Also available with integrated PM (permanent magnet) motor**



STEERPROP CONTROL SYSTEM

MODERN AUTOMATION SYSTEM

Steerprop Control System is built with carefully selected, widely-available components representing the latest, advanced industrial automation technology. Proprietary components are deliberately avoided. Standard components are chosen to ensure their availability for both current and future service operations and control system upgrades. All components are optimized by Steerprop Automation Design to be used with the Steerprop Control System.

Steerprop Control System is equipped with several layers of back-ups and redundancies to ensure vessel control in all situations. In case of failure in the main controls, system alerts the operator to manually switch to the back-up controls.

STEERPROP CONTROL SYSTEM - FEATURES

Steerprop Service Unit & diagnostic system allows combined control, monitoring and visualization of system settings and propulsor condition. It can be used to display control system component statuses, steering angles and propeller RPM, lubrication pressure and temperature in real-time. In addition it allows to access data trend history and logs. An in-built self-diagnostic system monitors control system operation & condition, system settings, feedback transmitters and steering speed.

Service Unit enables Steerprop service center to connect to the propulsor for **internet-based remote service**, provided the ship crew has connected the unit to internet.



STEERPROP SERVICE UNIT

Steerprop Control System can be **seamlessly interfaced** with any known control system, ranging from dynamic positioning systems to autopilots to satellite uplink systems. Same goes for any kind of prime mover - from electrical drives control by frequency converters to direct diesel drives.

TAILORED SYSTEM STRUCTURE

Control system can be tailored according to:

- o Vessel type and operation profile
- o Prime mover type
- o Dynamic positioning and integrated bridge systems
- o Vessel's other control, monitoring and automation systems



Steerprop **Operator Interface** is easy-to-use and informative, the indications kept as clear and simple as possible. Operating crew is provided with all the essential information in normal and abnormal operational situations.

SIMPLE AND INFORMATIVE

The modernized **Steerprop Control Levers** feature accurate and comfortable steering and can be set to provide the operator steering feedback, for example tactile feedback.

Steerprop Direction Indication (SDI) keeps the operating crew informed of all the important steering information from the Control System, such as propulsor angle, RPM, steering power and more - all combined on one screen.



STEERPROP DIRECTION INDICATION

STEERPROP FACTORY ACCEPTANCE TEST (FAT)

FACTORY ACCEPTANCE TEST

All Steerprop Azimuth Propulsors are subjected to full **Factory Acceptance Test** at Steerprop testing facility prior to their delivery to customer. The entire propulsor is tested together with its own control system to ensure they function flawlessly together.

TORQUE TEST

Torque test ensures all powertrain components - gear wheels, shafting, bearings - are in accordance with Steerprop's high quality standards.

In **full torque test**:

- o Propulsor is subjected to its full operational torque
- o Tooth contact patterns in gear sets carefully inspected & optimized
- o Power transmission in gear wheels optimized
 - o Optimal power transmission between gear wheels ensured
 - o Mechanical reliability and long service life assured



RUNNING TEST

At the start of **running test**, propulsor control system is linked to the propulsor. During running test:

- o All steering & control functions tested and calibrated
- o Propulsors run at full speed until testing temperature is reached
- o Propulsors run at operating speeds for the remaining test

During the running test, propulsors are closely monitored for following parameters and the results are carefully recorded in the **FAT report**:

- o Heating times
- o Pressures
- o Temperatures

If deviations are discovered, the test is immediately stopped and the deviations located and repaired before test restart. This will be repeated until the propulsor meets Steerprop's high standards for quality and efficiency.



CONTROL SYSTEM TEST

Steerprop control system is connected to the propulsor in accordance to project cable diagrams and always tested together with its individual propulsor to ensure they work perfectly in unison. During **control system test**, the main remote controls, back-up remote controls, local controls and local back-up controls are tested and calibrated, and control system software adjusted if necessary.

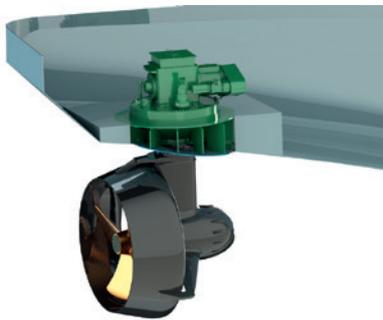
Reaction and steering ramp times etc. are carefully monitored and recorded. All alarms and other fault indicators are carefully tested to ensure their proper function. The comprehensive test ensures both control system hardware and software are working perfectly with the system's own propulsors and all cabling diagrams are correct.

STEERPROP PROPULSOR INSTALLATION

Steerprop Azimuth Propulsors are designed to be easy to install to any vessel type with installation options that can be altered to suit shipyard and owner needs. The same way as the propulsors are tailored to each individual vessel, the installation method can be specifically tailored to fit the client's needs and facilities.

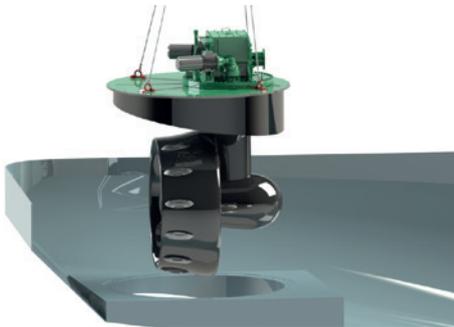
INSTALLATION OPTIONS

WELD-IN MOUNTING



In **large weld-in mounting** the propulsor is delivered in two pieces and the upper part welded into place. The welding connection is via radial stiffener plates. The lower part is then installed from below.

Weld-in installation provides the strongest bond with the hull and enables the use of minimal opening.



Large bolt-in mounting arrangement allows the entire propulsor to be installed in one piece from above. This single unit usually includes all auxiliary systems, such as lubrication. The unit is bolted in place.

For repair and maintenance, the entire unit can be removed or replaced in one piece, enabling comprehensive maintenance without a need to drydock the vessel.

Larger propulsors have limited installation options due to their size and weight. Often also the shipyard facilities such as lifting capacities and dry dock pool size set limits to propulsor installation.

Steerprop's larger propulsors are designed to allow a variety of different installation options - for example installation in two pieces from above or below and in one piece from below. In addition, Steerprop works closely together with the shipyard and the owner to find optimal installation method for the larger propulsors.

LARGER PROPULSOR INSTALLATION



Standard bolt-in installation in two parts



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